FEDERAL REPUBLIC OF NIGERIA

Annual Report on the Department of Agricultural Research

For the Year 1962-63

REPORT BY THE DIRECTOR

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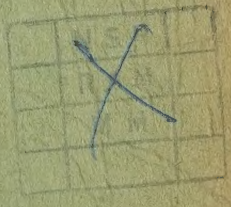
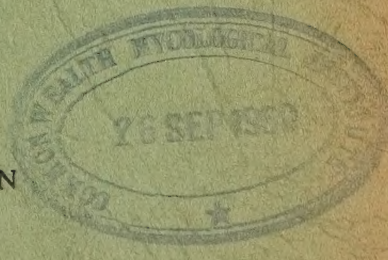




1964

FEDERAL MINISTRY OF INFORMATION
PRINTING DIVISION, LAGOS

FOREWORD

by

ALHAJI THE HON. WAZIRI IBRAHIM, M.P.,

Minister of Economic Development

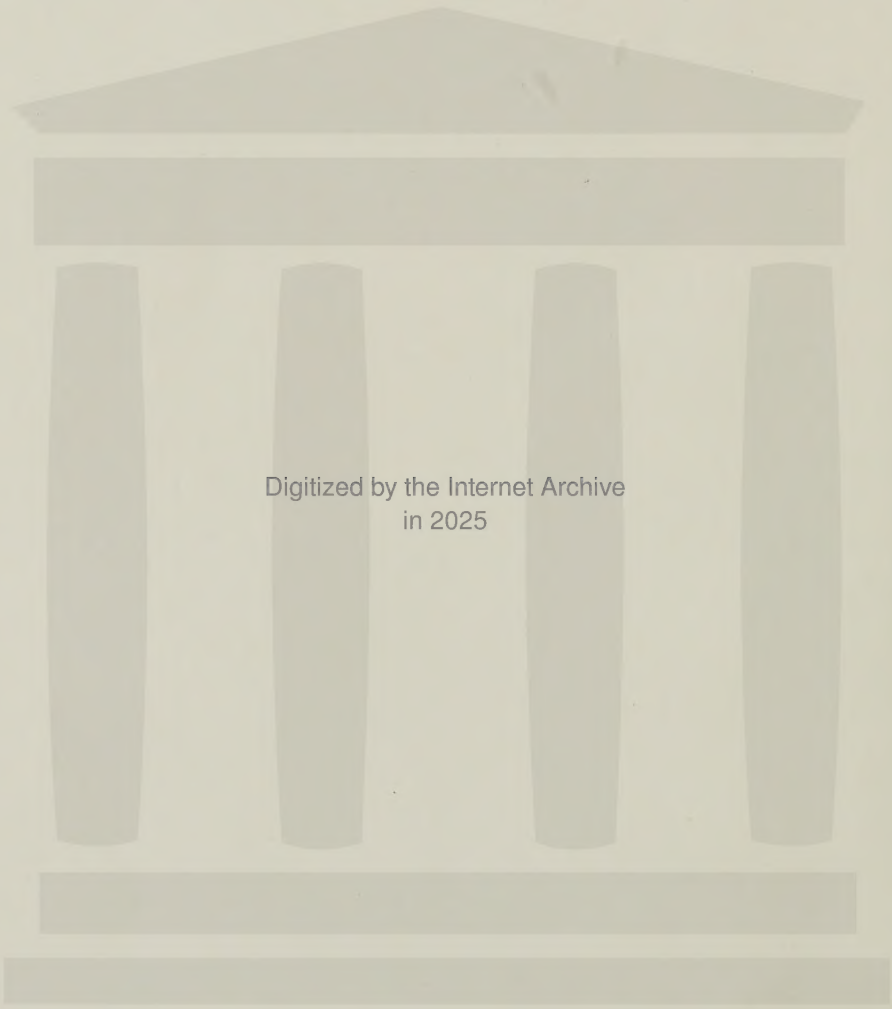
This Report which covers the period 1st April, 1962 to 31st March, 1963 records the work done by the Department on soil fertility and crop nutrition, improvement of the qualities of various food crops, the methods of planting the crops in order to obtain highest yields possible and the plant diseases and pests and their control. The work of the Department covers the whole country ; trials and investigations have been made in various localities spread all over the country.

Although the details of the research findings in the Report are recorded in scientific language, yet the Report is written in such a way that the layman can follow the outline of the trials and investigations. I hope, therefore, that both the layman and the scientist will find the Report interesting.

The Department has obtained many useful results which will definitely enhance the agricultural production of the country. The main findings have been reported in detail in separate memoranda. Also the Department has introduced from abroad many high yielding varieties of food crops. It is my earnest hope that the findings and the improved crop varieties will be adopted by the farmers throughout the country.

I wish to seize this opportunity to pay tribute to Dr Waterston, the former Director of Agricultural Research, who left Nigeria on retirement in July, 1962 after sixteen years of service in Nigeria. He did much to bring the Department to its present status. I wish him happiness in his retirement. To all the officers serving in the Department I wish to express my appreciation of the work they have so ably done and of their devotion to duty.

FIG. 1—HON. WAZIRI IBRAHIM, FEDERAL MINISTER OF ECONOMIC DEVELOPMENT, TRYING A HAND AT A WEST AFRICAN HOE FOR TILLING THE SOIL AT THE FEDERAL RESEARCH STATION, MOOR PLANTATION, IBADAN



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ACKNOWLEDGEMENT

We acknowledge with thanks all the help and co-operation this department has received from various bodies including other Minisries, Government Departments, Research Institutes within Nigeria and international organizations. Particular mention is made of organizations like FAMA, UNTAB and FAO for making available services of scientists to work on various agricultural research problems, during the period of 12 months under review. The association with Commonwealth Agricultural Bureaux, Rothamsted Experimental Station and other research organizations abroad has been most helpful and profitable.

G. E. O. Okiy,
Director of AgriculturalResearch

REPORT BY THE DIRECTOR OF AGRICULTURAL RESEARCH

Introduction

There was no change in the policy of the department during the period under review. The last six months saw the publication of a Quarterly Research Bulletin, which gives the progress report on research and other departmental activities; two issues were published during the last two quarters of the reporting period. This replaces the half-yearly report which ceased publication with No. 9 in June 1961. The department was fortunate to secure from international organizations the services of several technical assistance experts who worked on various, pressing research problems during the period: these include M. Andre Vaillant (Agronomist) of F.A.M.A., Dr J. Takahashi (Soil Chemist) of UNTAB and Dr T. Heikkinen (Soil Fertility Expert) of FAO, working on the Fertiliser Programme of the Freedom From Hunger Campaign which operates in Eastern and Western Nigeria. Dr Takahashi completed his assignment and left for Japan at the end of March 1963.

Visiting Missions

An FAO Agricultural Planning Mission invited by the Federal Government to conduct an agricultural survey for Nigeria arrived in the country in the second half of 1962 and continued their survey for the rest of the period under review. This department provided facilities for use by the experts as well as a counterpart and consultants for them during the exercise.

Conferences

The XIth Agricultural Technical Committee Meeting was held under the Chairmanship of the Director on 30th and 31st May, 1962 at the Regional Agricultural Research Station, Umudike, Eastern Nigeria, and the XIIth Meeting was held on 8th September, 1962 in Lagos. All the regions were represented. Many important issues vital to the development of agriculture in Nigeria were discussed and the decisions taken were passed on to the Ministry of Economic Development.

The department was also represented at several Regional agricultural meetings where cropping programmes were discussed.

The Director attended several meetings of the Faculty Board of Agriculture at the Universities of Ibadan and Ife during the period.

The department played host to the FAO West African Conference on Soils and Fertilisers which was held at Moor Plantation, Ibadan in November 1962 at which the Director presided.

Nigerian Commodity Research Institutes

The Director of Agricultural Research attended the Technical and Management Committee Meetings as well as staff Sub-Committee Meetings of the West African Institute for Oil Palm Research (WAIFOR) and the West African Cocoa Research Institute (WACRI). On the 1st of October, 1962, the inter-territorial status of the West African Research Institutes among which these are included, and the West African Research Organization was abolished, all the participating countries having decided to dissolve these establishments and agreeing that each country would take over the responsibility for any of these Institutes established within its borders. Accordingly, branches of WAIFOR and WACRI within this country became Nigerian Institutes. These Institutes continue to run in Nigeria as before, fulfilling their normal functions. New Constitutions are due to be passed for them by Government.

Staff

Dr J. M. Waterston, Director of Agricultural Research, left the department as Director on 8th July, 1962 on leave preparatory to retirement after almost sixteen years of service ; a Nigerian, Mr G. E. O. Okiy, formerly Chief Inspector of Agriculture, Eastern Nigeria, was appointed to fill this post in November, 1962.

There was some improvement in the recruitment into the department as more Nigerian graduates joined the department ; these include the following :—

Mr C. N. Ifeagwu (Botanist), Mr P. E. Onuorah (Mycologist), Mr T. O. Fadayomi (Agronomist) and Mr M. Bankole (Mechanic Demonstrator). Two expatriates, Messrs J. C. Burridge (Spectrographic Chemist) and Dr Ticheler (Agronomist) were appointed to the department on contract.

Messrs E. A. Dosunmu and J. A. Obi, Technical Officers, left for the United States of America to take a three month course in Plant Quarantine.

The authorised establishment of senior staff at the beginning of the year and the actual strength at 31st March, 1963 are given below. It will be noted that there was a total of 32 vacancies in an establishment of 97.

	Establish-ment	*Filled*	*Vacancies*
Professional			
Director	1	1	—
Deputy Director	1	1	—
Principal Research Officers	5	2	3
Senior Specialist and Specialist Officers	36	25	11
Scientific Officers (Soil Fertility Unit)	2	—	2
Librarian	1	1	—
Total Professional Staff	46	30	16
Higher Technical Staff			
Technical Officers	8	7	1
Assistant Technical Officers	14	12	2
Chief Laboratory Technologist	1	—	1
Superintendent Laboratory Technologists	3	—	3
Laboratory Technologists	5	1	4
Assistant Laboratory Technologists	7	6	1
Station Managers	2	1	1
Mechanical Demonstrator	1	1	—
Total Higher Technical Staff	41	28	13

	Establishment	*Filled*	*Vacancies*
Executive			
Senior Accountant	1	1	—
Higher Executive Officer	1	—	1
Executive Officer (General)	1	1	—
Executive Officer (Accounts)	1	—	1
Assistant Executive Officer (General)	2	2	—
Assistant Executive Officer (Accounts)	2	2	—
Records Officer	1	—	1
Personal Secretary	1	1	—
Total Executive Staff	10	7	3
Grand Total Senior Staff	97	65	32

The corresponding position for Junior Staff at 31st March, 1964 showed a total of 40 vacancies in an establishment of 263 as follows :—

	Establishment	*Filled*	*Vacancies*
Clerical			
Chief Clerk	1	—	1
Assistant Chief Clerks	2	2	—
First Class Clerks	11	9	2
Second and Third Class Clerks	23	23	—
Library Clerks	2	2	—
Stenographer, Grade II	2	2	—
Storekeeper, Grade III	1	—	1
Total Clerical Staff	42	38	4
Technical			
Senior Agricultural Assistant, Grade I	1	1	—
Senior Agricultural Assistants, Grade II	6	1	5
Agricultural Assistants, Grade I	11	3	8
Agricultural Assistants, Grades II and III	62	45	17
2nd and 3rd Class Agricultural Laboratory Technicians	7	6	1
Photographic Assistant, Grade I	1	1	—
Draughtsman, Grade II	1	1	—
Total Technical Staff	89	58	31

	Establish-ment	*Filled*	*Vacancies*
Minor Technical and Clerical (Scale F)			
Senior Field Overseers	7	6	1
Field Overseers, Grades I and II	56	56	—
Artisans	12	12	—
Driver-Mechanics	10	9	1
Clerical Assistants	13	13	—
Typists	9	9	—
Meteorological Recorder	1	1	—
Total Minor Technical/Clerical Staff	108	106	2
Sub-Clerical and Minor Technical (Scale G)			
Senior Laboratory Attendant	1	—	1
Laboratory Attendants	5	4	1
Stores Attendants	1	1	—
Telephone Attendants	3	3	—
Head Messenger	1	—	1
Messengers	13	13	—
Total Sub-Clerical and Minor Technical	24	21	3
Grand Total Junior Staff	263	223	40

As will be seen below, there are at present 288 substantive holders of posts in an establishment of 360 leaving 72 vacancies.

Progress of Nigerianisation as at 31st March, 1963

	Nigerian	*Expatriate* (P)	(C)	*Vacant*	*Total*
Professional	15	6	9	16	46
Higher Technical	28	—	—	13	41
Technical	58	—	—	31	89
Minor Technical	91	—	—	4	95
Executive	7	—	—	3	10
Clerical	38	—	—	4	42
Sub-Clerical	36	—	—	1	37
Total	273	6	9	72	360

(P) = Pensionable (C) = Contract terms

Nigerians undertaking higher training at the present time to qualify themselves for posts in the Department are as follows :—

Subject	*Number of Students*				
	Diploma	B.Sc.	M.Sc.	Ph.D.	Total
Agriculture	—	4	—	—	4
Botany	—	3	—	—	3
Chemistry	—	1	1	—	2
Mathematics	—	—	—	—	—
Zoology	—	1	—	—	1
Plant Pathology	—	—	—	1	1
Microbiology	—	—	—	1	1
Agronomy	—	—	1	—	1
Physiology	—	1	—	—	1
Entomology	—	—	—	1	1
Total	—	10	2	3	15

Distinguished Visitors to Agricultural Research Headquarters, Moor Plantation included : Messrs Alan Renouf, Australian High Commissioner, Lagos ; G. Akhurst, F.A.O., Rome ; Herman Oropeza, Centre de Investigaciones Agronomica Maracay, Venezuela ; Luis R. Gilparis, Sub Estacion Experimental de Zonas Aridas, Barqto, Venezuela ; M. A. Majekodunmi, Administrator, Western Nigeria, Ibadan ; Lambert Wiklander, Professor, Agric. College of Sweden, Uppsala ; E. D. Haliburton, Minister of Agriculture, Halifax, Nova Scotia ; Sir John Strachey, House of Commons, London ; E. J. Wellhausen, Rockefeller Foundation ; L. Kellbergs, Ambassador of Sweden ; Richard Bradfield, Cornell University, Rockefeller Foundation, New York ; John J. McKelvey, Jr., Cornell University, Rockefeller Foundation, New York ; Dr Gunter Gruner, Scherenbosted (Hannover, West Germany).

Distinguished Visitors to Federal Rice Research Station, Badeggi included ; Dr Ramsay, Soil Chemist, Regional Research Station, Samaru ; Dr P. Hesse, West African Rice Research Station, Sierra Leone ; Mr J. W. Hunt, Deputy High Commissioner, United Kingdom ; Professor K. M. Barlow, Department of Geography, University College, Ibadan ; Mr M. C. Kirkeberg, University of Wisconsin, U.S.A. ; Prince A. Lamuye, Parliamentary Secretary, Ministry of Finance, Lagos.

Distinguished Visitors to Federal Root Crops Research Unit, Umudike included ; Mr G. N. Herrington ; Mr Anderson of the Niger Delta Development Board, and Mr R. J. Swynnerton accompanied by Mr Nelson of Cameroons Development Corporation.

Senior Staff List at 31st March, 1963

Director of Agricultural Research	G. E. O. Okiy, B.Sc. (Ord) B.Sc. (Hons.) (Edin.)
Deputy Director of Agricultural Research	B. N. Webster, M.A. (Cantab.), M.Sc. (Nott.), M.I. (Biol.)
Senior Accountant	W. A. Daniju
Librarian	N. I. Shinie (Miss), B.Sc. (Edin.), A.L.A.
Personal Secretary	M. K. Fogarty (Miss)
Higher Executive Officer	S. B. Alalade
Principal Research Officer (Botanist)	J. E. Y. Hardcastle, B.Sc., D.A.S., D.T.A.
Principal Research Officer (Entomologist)	F. A. Squire, B.Sc., A.I.T.A.
Senior Specialist Officers (Botanists)	B. D. A. Beck, B.Sc., D.A.S., D.T.A.
	C. L. M. Van Eijnatten, L.I.
	A. W. Waitt, B.Sc., D.A.S., D.T.A.
Senior Specialist Officer (Spectrographer)	J. C. Burridge, M.A., M.Sc.
Specialist Officers (Botanists)	J. A. F. M. Sluyters, L.I.
	T. Van der Feijst, L.I.
	C. N. Ifeagwu, B.A., M.Sc.
Specialist Officers (Agronomists)	T. J. Bredero, L.I.
	P. M. Chinwuba, B.A., B.Sc., M.Sc.
	F. O. C. Ezedinma, B.Sc., M.Sc.
	J. H. G. Ticheler, B.Sc., Ph.D.
Specialist Officers (Chemists)	M. N. Nwaji, B.Sc., Ph.D.
	M. N. Okafor, B.Sc.
	E. N. Ugochukwu, B.Sc.
Specialist Officers (Entomologists)	T. A. Taylor, B.Sc., Ph.D.
	S. O. Boboye, B.Sc.
Specialist Officers (Mycologists)	A. G. Bailey, B.Sc., D.A.S., D.T.A.
	S. A. Anibaba (Miss), B.Sc.
Specialist Officers (Plant Pathologists)	D. G. Roberston, M.A., D.A.S.
	P. E. Onuorah, B.Sc.
Specialist Officer (Soil Fertility)	M. H. D. F. Fyfe, B.Sc., Dip. Agric. (Cantab.), D.T.A.
	T. O. Fadayomi, B.Sc.
Technical Officers	J. K. Olurin
	A. A. Ononokpono
	E. A. Dosunmu
	J. A. Obi
	N. N. Okparanta
	M. J. Ekandem
	E. U. Edem
Laboratory Technologist	S. N. Muotoe
Station Manager	S. A. Soremi
Mechanical Demonstrator	M. A. Bankole

Visiting Scientists

F. A. O. Soil Fertility Expert	T. Heikkinen, Ph.D.
F. A. M. A. Agronomist	A. Vaillant
U. N. T. A. B. Soil Chemist	J. Takahashi, Ph.D.

PROGRESS IN RESEARCH
MOOR PLANTATION

PLANT PHYSIOLOGY

Crop Nutrition

Leaf development of cassava

The number of leaves, leaf scars and leaf area were measured on growing cassava plants in order to follow up the expansion of leaf area and the relation of area with the time. Data have been collected for 18 months and are now under analysis.

Sweet potato fertiliser trial

A fertiliser trial was carried out in 1961 at Ilora. The results have now been analysed. The figures were analysed on basis of the yields per plant, as the stand count was low due to the occurrence of a serious drought in the first weeks of development of the crop. The following conclusions were reached.

The application of 80 lb. of potash per acre caused an increase of 50 per cent in yield and an application of 40 lb. of potash (as muriate of potash) increased the yield by 25 per cent. This was true both for the total tuber yield and for the yield of marketable tubers. Nitrogen significantly decreased the yield of both the total yield of tubers and the yield of marketable tubers per plant. A similar effect was noted on the development of the vine. Nitrogen was given in doses of 30 lb. and 60 lb. per acre as sulphate of ammonia. Calcium gave, at a dose of 84 lb. per acre (as Buxton lime), a barely significant increase in yield of marketable tubers. The N x P interaction indicated that an increase in yield occurred with superphosphate in the absence of nitrogen. The differences were however only just significant. The application of magnesium did not influencee the yields nor did the application of a mixture of various trace elements (Mn, Bo, Sn, Ca, Mg and Fe).

Nutrient contents of various plant species

Leaf samples were collected from seven plant species (*Piper nigrum*, *Musa sapientum*, *Carica papaya*, *Glycine javanica*, *Tectona grandis*, *Coffea robusta*, *Mucuna*) at monthly intervals and analysed for N, P, K, Ca, Mg, Fe and Mn. Samples consisted of leaves not fully matured, usually the 3rd or 4th leaf from the apex. The available results are shown below :

Months	*Crop*	*% N*	*% P*	*% K*	*%Ca*	*%Mg*	*ppm Fe*	*ppm Mn*
April		4.4	0.3	3.7	0.7	0.3	57.5	60.9
May	Piper	3.4	0.2	3.1	1.0	0.3	22.9	46.5
June	nigrum	3.4	0.2	3.1	1.1	0.3	113.6	68.6
April		3.2	0.2	3.6	0.5	0.3	89.2	217.2
May	Musa	3.00	0.2	3.4	0.6	0.3	41.1	415.0
June	sapientum	3.00	0.2	—	0.4	0.3	73.2	335.2
April		4.4	0.4	2.1	1.3	0.8	133.9	135.0
May	Carica	3.8	0.4	1.4	1.7	0.9	121.5	46.7
June	papaya	5.5	0.4	2.0	1.2	0.9	100.5	93.8
April		5.1	0.4	3.00	0.7	0.3	120.3	35.5
May	Glycine	4.4	0.4	2.8	0.9	0.3	233.9	52.1
June	javanica	4.7	0.3	2.4	1.1	0.4	115.7	73.2
April		2.5	0.3	2.1	1.2	0.3	68.5	40.3
May	Teitora	2.7	0.2	1.6	1.2	0.3	60.8	60.5
June	grandis	2.7	0.2	1.0	0.4	0.2	88.4	—
April		3.3	0.2	1.9	0.7	0.2	45.8	17.9
May	Coffea	3.2	0.2	2.4	0.8	0.2	48.2	23.3
June	robusta	3.1	0.2	1.9	0.7	0.3	62.7	32.9
April		4.7	0.3	4.5	0.9	0.4	149.7	179.0
May	Pueraria	4.3	0.3	2.1	0.8	0.3	75.0	—
June	javanica	4.2	0.3	1.9	0.8	0.3	111.7	—

Nutrient content of maize leaves versus yield

On 20 sites on Moor Plantation a plot of maize was planted in order to study variation of and relations between contents of various elements in leaves and the yield. Maize leaf samples were taken at two and a half week intervals, using the 6th, 9th and 12th leaves if available. Soil samples were taken from these plots in order to assess apparent differences in fertility. The samples have now been analysed, and are being examined statistically.

The above experiment was followed by a study of the nutrient removal by a maize crop in relation to the yield level. Various plant parts were sampled from plots and chemical analyses are being carried out.

TREE CROPS

Coffee

Each variety of coffee in the collection is grown at a spacing of 12ft x 12ft for the Robusta and Liberica types, 10ft x 10ft for Stenophylia and 8ft x 8ft for Arabica. *Gliricidia* which had been well established were cut back and Albizzia planted between the rows of *Gliricidia*. The *Albizzia* is not yet old enough to give a satisfactory shade.

Flowering of the coffee commenced after the first few showers of rain ; harvesting and yield recording of the crops commenced about October, and continued till the middle of December.

Immature berries were removed and burnt, at the onset of the rains as they constitute a source of infection by coffee berry borers (*Stephanoderes hampei* Ferr).

Yields increased gradually in the third year following pruning. The following were the yields recorded :

TABLE SHOWING 1962 YIELD OF COFFEE RECORDED FROM ½ ACRE PLOTS ON MOOR PLANTATION EXPRESSED IN POUNDS FRESH BERRIES

Plot	*Type*	*Year of coppicing*	*Trees in bearing*	*Yield in* lbs.	ozs.	*Mean Yield in lbs. per bearing tree*
A	G. C. Robusta	1959	109	452	7¾	4.1
B	Liberica I	1953	121	3522	10	29.1
C	Quillou Rob.	1959	114	800	8	7.1
D	Stenophylla	1960	89	38	1¼	0.4
E	Java Robusta	1959	80	159	0	2.0
F	Arabica	—	0	—	—	3.0
G	Uganda Rob.	1959	116	385	10	23.1
H	Liberica II	1953	114	2624	1	2.3
J	Excelsa	1960	94	204	13	1.3
K	Uganda No. 1	1960	55	68	11	0.8
L	Uganda No. 257	1959	32	24	12½	2.5

Kola

Productivity of kola on observation plots at Agege.—Analysis was made of yield figures obtained during the past twelve years from the locally planted kola plantations at Agege, which are under our supervision. The figures from various yields were grouped into a frequency distribution of which the classes were defined by the average yield level and its standard error. Twenty-eight trees, that is, 5.3 per cent of the number available, were selected for clonal testing as they had a yielding performance more than twice the standard error added to the population mean.

Further observations are that 63 per cent of the annual production is harvested during the last quarter of the year. The heaviest nuts are produced during the main harvesting season. One of the selected trees, AF44, produced 53 per cent of its yield during the 2nd and 3rd quarters of the year, that is, in the "off-season". The population average of this period was 16 per cent.

The above-mentioned desirable characters, that is, high yield and more even distribution of the yield over the year shown by various trees, must be tested on their genotypic or phenotypic nature. To this effect clones are being established by the rooting of cuttings.

The total weight of nuts produced at Agege shows an apparently cyclical alternation of one productive season with two less productive seasons. This phenomenon seems only partially due to overall climatic conditions as in only one of the three peak years did all plots show a productivity above the average. The results are reported in extenso in Memorandum No. 42.

Rooting of kola cuttings.—Cuttings from some of the selected trees root very easily. For example, cuttings from Tree AA231, one of the Agege selections, gives regularly a 90-100 per cent success with the rooting of cuttings. Tree AA86 however gives a success of only 12 per cent. The cuttings of AA86, produced a prolific growth of callus, but often failed to produce roots.

Kola rootstocks.—Kola rootstocks have been selected (*see* Memorandum 34). The vigorous rootstocks have now been multiplied by the rooting of cuttings. The trees selected as weak rootstocks had to be coppiced in order to produce new shoots, which developed within six weeks. When those shoots are hardened they will be used for rooting purposes.

Planting methods trial

A trial to compare a number of planting methods for kola was designed to include (*a*) depth of planting, (*b*) position of seed, (*c*) cutting of tips of seeds and (*d*) shade. Seeds which showed clearly the ventral and dorsal sides, base and tip were selected from seeds obtained from Agege ; each seed weighed between 16 and 18 grammes. The seeds were planted either vertically, dorsally, ventrally or laterally. A total of 3072 seeds were sown ; the tips of some of the seeds were cut before sowing. The depths of planting were 0, 2 and 4 inches ; half the replication were shaded, and the other half remained without shades. The beds were forked periodically and watered daily.

Several of the seeds in the various treatments have emerged ; observations on germination and height measurements of the various seedlings are in progress.

Observation on the development of rooted cuttings and seedlings

A trial was laid down to study the development of kola planted as rooted cuttings or as seedlings, with a view to ascertaining, which type of planting material can be successfully employed for the establishment of this crop.

The experiment is laid out in the form of a replicated randomised block with four treatments. The plot size was 36 square feet, and the total area employed was 0.04 acres ; the plants were spaced 6ft x 6ft apart.

Twenty plants each of Agege selections AA62, AA86 and AA231 from a group of rooted cuttings and 20 from the cross AA231 x AA86 were selected on the basis of age, uniformity and growth and vigour for purpose of planting. Holes 3ft x 3ft x 3ft were dug and filled with a mixture of surface soil and subsoil.

Planting commenced in September 1962. 80 plants altogether were set out. The plants were heavily mulched and shaded. Watering was carried out during the dry season. Growth following planting was luxuriant.

The occurrences and frequencies of flushes are being recorded at monthly intervals. At half yearly intervals, measurements of the heights and girths of the plants will be made. One plant of each treatment will be dug up for a study of the root development and aerial growth.

Clonal test at Agege.—In August 1962, a small experiment was planted in plot AA with clonal material obtained by rooting of cuttings from three selected high yielding trees AA62, AA86 and AA231 at Agege in an attempt, firstly, to test whether the high yielding qualities of these trees are due to their genotype and not a reflection of an outstanding location of these trees.

The trial consists of a randomised block layout of two treatments using selections AA86 and AA231 for the main trial, surrounded by AA62, and AA231 planted alternately, as discards. A total of 32 trees altogether were planted. The plants were heavily mulched, shaded and watered during the dry season.

Price fluctuation of kola.—An observation was started to obtain information on price fluctuations of kola of both *C. nitida* and *C. acuminata* and the relationship which exists between this and size or colour of nuts, in any season from year to year. Small samples of nuts of various sizes and colours were purchased (retail and wholesale) at fortnightly intervals. The nuts were serially numbered, the size, colour and the number of cotyledons per nut were noted, the weights taken and the relative prices recorded.

Acquisition.—In 1962, a total of 15 kola acquisitions in the forms of cuttings and seeds consisting of the following were made :

Variety	*Parent tree*	*Source*	*Remarks*
C. nitida	T 16	Labochi	Received as cuttings
C. nitida	T 22	Labochi	Received as cuttings
C. nitida	T 27	Labochi	Received as cuttings
C. nitida	T 161	Labochi	Received as cuttings
C. lateritia	A4/5	Cameroons	Received as cuttings
C. lateritia	B4/4	Cameroons	Received as cuttings
C. nitida	A8/7	Cameroons	Received as cuttings
C. nitida	A8/12	Cameroons	Received as cuttings
C. nitida	A8/13	Cameroons	Received as cuttings
C. lateritia	A4/5	Cameroons	Received as seeds
C. lateritia	A9/1	Cameroons	Received as seeds
C. nitida	A2/9	Cameroons	Received as seeds
C. ballayi		Central African Republic	Received as seeds
C. nitida		Ondo	Received as seeds

Citrus

Yield trials.—Of the several rootstocks used in a small orange trial laid down in B6 in 1952, using a Nigerian green sweet orange described as Agege No. 1, as the scion, Lake Tangelo, and Cleopatra Mandarin gave the best result both for vigour and for yield. During the last ten years (1952 to 1962), the mean yield expressed in pounds per bearing tree was 381.0 for Lake Tangelo and 305 for Cleopatra Mandarin.

In a varietal trial in which both local and introduced oranges were tested, using Cleopatra Mandarin as the only stock, the variety Meran (Ex Abeokuta) was outstanding.

Collections.—Various citrus introductions and other fruit trees not yet available on Moor Plantation, are being propagated for planting into a fruit tree collection. Planting was started in August 1962.

Fourteen citrus varieties, budded onto each of the three recommended rootstocks (Lake Tangelo, Cleopatra Mandarin and Willow leaf Mandarin) and a few mango and avocado varieties have been planted.

Avocado

In the search for suitable planting materials, 49 avocado plants on Moor Plantation, and 22 at Agege have been described and tagged for purpose of recording. The fruits from the bearing trees have been collected for observation, yield and taste tests. Observations were commenced in order to study the occurrence of flowers and frequency of fruiting.

FOOD CROPS

Maize

Selection of S1-inbred lines from Nigerian floury varieties of maize, initiated in 1958, brought its first results in the identification of seventeen floury lines with a high combining ability from amongst a large number of selections from the following varieties : Akwete White flour, Ikom white flour and Lagos White. The selection was made by topcrossing newly established S1-inbred lines to a white dent maize variety, ES2. The topcrosses were then grown in yield trials and the best performing topcrosses were taken to indicate the best S1-lines. The seventeen S1-lines are now under multiplication for further experimentation in order to obtain a synthetic variety with the yielding capacity of the white dent maize types from Mexico (Mexico 5, ES2, Sicaragua, Eafro 231) and the floury, soft grain character of the local maizes in Southern Nigeria (*see* Memorandum No. 41).

Production of floury synthetics.—After multiplication by hand-pollination of selected white floury inbreds eighteen of these EWS lines were sown in isolation on an irrigated field at Moor Plantation in order to obtain by open-pollination a synthetic composed from high combining floury inbred lines. This material has been interplanted with six highly combining white dent inbreds (EWD lines), in order to produce a synthetic, combining the floury characteristics of the local varieties with the high combining ability of the Mexican tuxpeno race of maize.

Palatability tests.—Palatability tests were arranged with the co-operation of wives of several of our staff members. The purpose was to find out whether any difference existed in the acceptability of 'Ogi' and 'Eko' prepared from the local floury variety or from the Mexican type of maize. The influence of sieve meshes used to separate the flour from the chaff on the acceptability of the preparation was also investigated. Preliminary conclusions are as follows :

If ogi was prepared from flour produced with a "wet milling process", coarser flours obtained with a sieve of 25 mesh, were more acceptable than finer flours, obtained with sieves of 36 or 60 mesh. The Mexican type of maize was preferred above the local variety. If the ogi was prepared with dry milled flours, then the finer local flours were preferred above the preparations from the Mexican maize. The coarse local flour (obtained with a sieve of 25 mesh) however was least acceptable.

The 'eko' preparations were prepared from wet milled flour only. The Mexican maize type gave the best-tasting eko preparation if the flours were obtained by using sieves of mesh 60 or 36. Next in rank was the Lagos White flour obtained with a sieve of 60 mesh. Coarser Lagos White flours ranked even lower than the coarsest Mexican flour (25 mesh).

The performance of six white grained maize varieties in varietal hybrid combinations has been tested in a number of yield trials in the past two years. The results appear very stimulating in that one of the best combiners was found in a local variety with the soft floury type of endosperm in the grains, so highly valued in Southern Nigeria. It also is promising that the mean performance figures varied from 27.3 to 42.5 per cent over the average yield of the parent, varieties.

The varieties with the highest general combining ability were Sicaragua and Lagos White closely followed by Eafro 231.

Tasseling time of maize.—A number of factors have been considered, which could possibly furnish an explanation of the variation in tasseling times, observed at Ibadan in 1959/1960. This phenomenon probably occurs more generally. The variability of the determining factor, or of the equilibrium between several major determining factors, is exhibited clearly in a reversal of the relation of tasseling times for early and late crops in 1958. The graph representing tasseling observations on a serial planting during a year in 1959–60 suggests that rather sudden changes occur from long to short and short to long tasseling time durations.

Observation on monthly plantings at Samaru and at Ibadan in 1961 and 1962 confirmed the existence of a cyclical variation of tasseling times of maize with the time of planting.

Daylength studies revealed that tassel initiation occurs after approximately thirty days under photoperiods of 12 to 13½ hours and other environmental factors as prevalent at Ibadan during the period from July to September 1962.

Recording system.—During the year the recording system as applied in the maize breeding section of this department was described in a memorandum, which is now being printed.

Visits to maize millers.—Information was obtained from various milling centres at Ibadan, in Oshogbo area and in a few locations in the riverain provinces on the types of grain mills used for processing maize grains. The 'Premier' mills were those commonly used. They were powered electrically or with diesel engines. The mills were used both for dry and for wet milling. Wet milling seemed the more common method.

Preference for white maize varieties was very marked as the populations in most of the locations visited were Yoruba. Various reasons were advanced of which 'tradition' seems to be the most important.

A study of the development of two varieties of maize

Zea mays is stated to be one of the more efficient plants of the world in dry matter production. A very fast development of maize plants occurs. A better understanding of their development was sought using growth analysis techniques. Two varieties of maize have been studied, which proved to have a very different yielding performance, in spite of a rather similar vegetative development. It was shown that Lagos White, the local variety, produced approximately 2,000 lb. per acre and ES2 3,000 lb. per acre.

From approximately the ninth week onwards the ear develops rapidly. From whatever angle the processes were considered, the retention of a larger potential photosynthetic area by the introduced variety ES2 from the eighth week onwards, seems to be the major factor controlling the higher production of dry matter in the latter part of the plant's development, compared with Lagos White plants.

On the average, NAR had similar values in both varieties and had similar deviations at various stages of development; external or internal factors could not be separated. The LAR indicated that, certainly in the latter part of development, ES2 plants and Lagos White plants had a similar leaf area per gram dry matter; but ES2 had more of both. This factor stresses the similarity of efficiency in both photosynthetic mechanisms.

The leaf area index shows in clear terms the difference between the two varieties grown at equal spacing. The variety ES2 still increased its leaf area with its additional laminae, when Lagos White had come to a standstill. Lagos White had a more rapid loss of leaf by senescence. The more pronounced longevity of the photosynthetic area in ES2 appears therefore the major determinant of the higher production of dry matter by this variety.

Selection of leafblight-resistant lines.—One hundred and two S3-inbred lines of West African origin, were tested for their resistance to the leafblight, caused by *Cochliobolus heterostrophus*. Nineteen lines were selected in order to establish a population which can serve as a basis for selection of material with a higher resistance.

Shortnoded maize material.—Investigation into the possibility of shortening the height of tall maize varieties by crossing it to short-noded (brachytic) materials was continued. If successful, it is hoped that the resulting variety will be a low, short-stemmed and broad-leaved plant which can be grown at a closer spacing than the tall variety, and will produce an aggregate yield per acre which will compare favourably with the yield of other high yielding varieties.

Maize shelling tests.—Tests were commenced a couple of years ago to determine the optimum stage of dryness at which machine shelling of maize could be undertaken with minimum risk of damage to the grains.

Three types of maize—flint, flinty-flour and flour—were each shelled at different stages of dryness. The results show that machine-shelling could be done without much damage even when the moisture content is as high as 38 per cent depending on the size of the grains. If the ear and the grains are large appreciable damage may occur.

Economic Collection

The collection of economic plants has now been transferred to a new location (field A7 and D7 on Moor Plantation), where all annual material is propagated on standard size plots (11 ft × 22 ft). The collection includes varieties of *Carica papaya*, pineapple, banana, legumes, a number of local vegetables, sugar canes, fodder canes and various grasses. Lists of available plant material have been circulated within Nigeria. It is intended to do this annually.

Seeds are now stored in the airconditioned seedstore on Moor Plantation, where the temperature is kept at 8°-9°C and the relative humidity at 50-60 per cent, as viability dropped below 50 per cent for many of the crops when stored under ambient conditions. Any seed of which the viability now drops below 50 per cent will be regrown. This is not likely to happen within less than four or five years for many of the crops and this will therefore considerably reduce the costs of maintaining the collections.

Much material was distributed within Nigeria. Rama and Aramina fibre crops were sent to North Borneo. Pineapple material was sent to Jordan.

FIG. 2.—HON. WAZIRI IBRAHIM, FEDERAL MINISTER OF ECONOMIC DEVELOPMENT, BEING SHOWN, IN A MAIZE FIELD, A SAMPLE OF MAIZE POLLENS FOR USE IN "SELFING"

AGRONOMY

Maize

Yield trial results.—Yield and adaptation trials involving several introduced maize varieties were continued in 32 locations in the country. A local variety was also entered as a tester in each location.

Trials in Northern Nigeria.—Best yields were obtained in Kabba, Jama'a and Oturkpo where the highest yielding varieties exceeded 3,000 lbs. of dry grains per acre. Intermediate yields of about 2,000 lbs. per acre from the best performing varieties were obtained at Okuta, Kwali, Jalingo, Samaru, Ochanja and Osara. Highest yields attained by the top ranking varieties at Zonkwa, Oke-Onigbin, Bauchi, Mubi, Mokwa, Akwanga, Lafia and Takum were about 1,000 lbs. per acre. Maize variety, ES1, has, in these and previous trials, proved to be adapted and a good performer over a wide area of the riverain provinces. This variety has therefore been recommended for multiplication.

Trials in Eastern Nigeria.—Yield trials were carried out at Umudike, Ogoni, Ikom, Nekede and Calabar. The results presented in Table 1 were similar to those obtained in 1960 and 1961 trials.

TABLE I

PERFORMANCES (LBS/ACRE) OF 8 MAIZE VARIETIES AT 5 STATIONS

Variety	*Umudike*	*Ogoni*	*Ikom*	*Nekede*	*Calabar*	*Mean*
ES1	1,917	2,028	2,969	2,332	1,360	2,121
Mexico 5	2,067	2,264	2,703	2,168	1,240	2,088
Trinidad	1,975	1,684	2,652	1,902	1,369	1,916
Eafro 231	1,774	1,871	1,704	2,193	654	1,640
ES2	1,442	1,549	2,016	1,943	1,077	1,605
Eafro 237	1,348	1,038	2,042	1,631	—	1,514
Local	1,527	1,130	1,481	1,638	810	1,317
Sicaragua	—	—	—	—	867	—

ES1 has been recommended for multiplication because it has consistently performed well in all the stations over a number of years.

Trials in Western Nigeria.—Yield trial data for 1962 early season were obtained from 8 locations ; Ibadan, Ilora, Agege, Ketu, Ipokia, Akure, Ondo and Kwale. Best yields were obtained from Mexico 5, Eafro 231 and ES1. ES1 and Eafro 231 are now being multiplied and will be ready for distribution in the very near future.

Plant population studies.—Studies on optimum rates of planting of three maize varieties, Lagos White, Mexico 5 and ES1, were made at Ibadan, Ilora and Agege, using 17,400 14,500, 11,600 and 8,700 plants per acre. The results obtained are shown in Table II.

TABLE II

THE YIELD (LBS ACRE) OF 3 MAIZE VARIETIES AT 4 RATES OF PLANTING IN 3 LOCATIONS

Location	*Variety*	*No. of Plants per acre*				*Mean*
		17,400	14,500	11,600	8,700	
Ibadan ..	ES1 ..	2,366	2,594	2,163	1,850	2,243
	Mexico 5 ..	2,213	2,163	1,739	1,356	1,868
	Lagos White ..	1,613	1,335	1,283	1,091	1,331
Ilora	ES1 ..	2,160	2,000	1,793	1,749	1,926
	Mexico 5 ..	2,186	1,899	1,578	1,530	1,798
	Lagos White ..	1,128	1,081	894	779	970
Agege ..	ES1 ..	1,281	1,132	1,094	1,131	1,160
	Mexico 5 ..	1,225	821	1,107	771	981
	Lagos White ..	837	695	884	651	767

The 17,400 plant population gave the highest yield for all three varieties at all locations except at Ibadan where ES1 gave the highest yield at 14,500 population. There was no significant difference in yield between individual varieties at 17,400 and 14,500 populations at Ibadan and Ilora, but all the varieties yielded significantly higher at these two rates than at 11,600 and 8,700 populations. There was no significant difference in yields between individual varieties planted at different rates at Agege. Agege soils being very light and sandy did not seem to afford good anchorage to maize root systems and as a result many plants, particularly those at high planting rates, lodged badly.

At Ibadan there was some evidence of increase in number of ears per plant from 17,400 to the 8,700 plant populations. Increase or decrease in number of ears per plant as a result of different planting rates was, however, not observed at Ilora and Agege.

Fertilizer trials

Preliminary investigations were made in 1962 at Ibadan, Ilora and Agege to determine the response of maize varieties ESI, Mexico 5 and Lagos White to applications of mixed fertilizers at the rates of 0, 300, 500 and 700 lbs. per acre and in a 12-8-12 combination. The three varieties responded in yield up to 500 lbs. but gave little or no additional response with applications of 700 lbs. of mixed fertilizers per acre. ES1 and Mexico 5 appeared to respond more favourably than Lagos White to fertilizer applications.

Popcorn

A pearl type of popcorn introduced from the U.S.A. has been grown successfully for more than three seasons at Ibadan. A reliable method of measuring its propability has not yet been clearly defined, but preliminary tests carried out so far have indicated that this variety has a higher popping expansion than local flinty varieties commonly used for popping in this country. Seeds of this variety will be planted at Bida in 1963 for further observations and tests. Other recent introductions are being observed at Ibadan.

FIG. 3—RESEARCH ON THE COWPEA WHICH IS AN IMPORTANT SOURCE OF PROTEIN. HERE AN AGRICULTURAL ASSISTANT TAKES A MEASUREMENT OF THE VEGETATIVE GROWTH WHICH DETERMINES THE YIELD

Sweet corn

Pajimaca sweet corn introduced from Cuba, has been observed for many years at Ibadan. Its performance is satisfactory and it is now being grown for further tests in other Regions of the Federation. Two other introduced varieties of sweet corn are still being observed at Ibadan station.

Cowpeas

Plant and seed characters

Observations were continued at Ibadan on the characteristics of Nigerian and introduced cowpea varieties. The data already collected during the past two years have been processed and will be reported elsewhere.

Drying of cowpea seeds

The effect of alternate wetting and drying on subsequent germination of cowpeas was studied. High percentage germination was obtained when dry cowpea seeds were steeped in cold water at room temperature for 3 hours and subsequently dried at 40°C for 12 hours. Germination of seeds dried at higher temperature declined sharply and reached the lowest limit (zero germination) when the seed were dried at 75°C for 5 minutes.

The results suggest that satisfactory drying of cowpea seeds harvested in wet weather could be achieved at moderate heat without reducing viability of the seeds significantly.

Depth of planting

The optimum depth of planting cowpeas in the field was shown to be 2-5 cm. Below 7 cm., germinating seedlings exhausted themselves prior to emergence and made very poor growth subsequently.

Yield components

Preliminary results indicated that most cowpea varieties tested are potentially capable of high yields. Yield determinants in cowpea included the number of pods matured per plant, number of seeds per pod and size of the seeds. There were varietal differences in these characters but their effect on final yield often depended on environmental factors. Losses of flower and pods caused by unfavourable weather conditions coupled with severe pest damage resulted in low yields or total crop failure. Investigations are being continued on the influence of environmental factors on yield expressions in cowpeas.

Effect of natural day-length changes

Studies at Ibadan showed that most upright cowpea varieties flowered, set and matured their pods within the same length of time when planted between April and October. A few trailing types on the other hand exhibited short day reaction. Yield expectation was higher in the early (April-July) than in the late (September-October) planting, but losses from insect damage and unfavourable weather conditions were higher in the early crop, resulting in very low harvestable yields.

The association of day length sensitivity with trailing habit of growth is being studied in greater detail. Most trailing varieties however, appear to be short-day plants suitable for late season cropping only.

Plant spacing and population

Results of early and late season trials at Ibadan indicated that at similar spacing distances, there were no significant differences in the dry matter and bean yield of upright and trailing varieties of cowpea. The dry matter yield of upright and trailing types increased linearly with increase in number of plants per acre. Dry matter yield per unit area was significantly higher

at narrow than at wide spacing. Size of individual plants decreased by one-third and one-half when two and three plants respectively were grown together on a hill. Spacing distances of 3 feet by 2 feet and 3 feet by 1 foot appeared to be optimum for early and late season sole crop cowpeas respectively. The investigation continues.

Soyabeans and Pigeon Peas

Planting dates of soyabean and pigeon pea

Soyabean.—Sixty-one varieties of soyabean planted every mid-month from April through October 1962 flowered, set and matured their pods within approximately the same length of time. It was, however, easier to harvest and handle the late (July-October) than early (April-June) crop, because of adverse weather conditions at the time of harvesting.

Yields varied with time of planting. The highest yields (maximum 1,500 lbs per acre) were obtained from July and August plantings whilst lower yields (500-50 lbs per acre) were obtained from September and October plantings. Decrease in yields in the later period was probably due to reduction in growth period of the plants. Mid-season (July-August) planting of soyabean in Ibadan area will be studied in greater detail.

Pigeon pea.—Flowering and podding in pigeon pea in relation to time of planting was studied at Ibadan. Four varieties were planted every month from April to August and flowering was observed after five months from each planting date. It was however, observed that all flowers set in October and November abscissed whilst those produced in December and subsequent months yielded fruits normally. The factors influencing flowering and pod setting are being investigated.

FEDERAL RICE RESEARCH STATION

Development of the station

The construction of the deep water tank continued. This tank will be used to simulate the rapid rising, deep floods which occur in the naturally inundated river valleys of Nigeria. It will provide a controlled and easily accessible environment for the evaluation of new acquisitions and for the preliminary selection of hybrids adapted to these conditions.

Two lysimeter tanks have been constructed and will be installed in the fadama. They will be used to estimate the water requirement of shallow swamp rice and to develop suitable evapotranspiration formulae for the crop.

Meteorology

The recording of data from the two meteorological stations on the Station was continued.

The total rainfall for the year was slightly below average. The early rains were light and there was a pronounced dry spell in July. Rainfall in August, September and October was high. Parts of the fadama were flooded in September and the floods caused considerable damage to trials and to the Variety Collection.

Plant Breeding

Four distinct ecological zones are used for the growing of rice in Nigeria; these are naturally inundated lowlands, the non-inundated irrigable lowlands, the rainfed uplands, and the fresh water mangrove swamps.

It is not possible to obtain a single rice variety with a sufficiently wide range of adaptation to cover all the major zones of rice growing in Nigeria. These zones integrate with one another and in the marginal areas a variety typical of one zone ; may have a sufficiently wide range of adaptation to be superior to varieties from the neighbouring zone ; but where the ecological conditions are clearly defined it is unlikely that varieties adapted to one environment can compete successfully in another. Indeed, it has been shown in the shallow swamp rice improvement programme that if the major zone, the non-inundated irrigable lowlands, is further subdivided it is possible to select varieties for specific areas within the zone. For this reason the plant improvement programme is divided and related to individual zones. In 1961 attention was concentrated upon the first three zones. Mr J. E. Y. Hardcastle worked on the breeding programme for the naturally inundated lowlands, Mr J. A. F. M. Sluyters on the programme for the non-inundated irrigable lowlands and Mr B. D. A. Beck on the programme for the rainfed uplands. Mr B. D. A. Beck also collaborated with Mr Hardcastle on the evaluation of the *Oryza glaberrima* varieties and the *O. glaberrima x O. sativa* hybridisation programme.

The naturally inundated lowlands

The fadamas of the major river systems of the far North of Nigeria are subject to seasonal deep flooding. They are the traditional areas of cultivation of the indigenous, red grained varieties of *Oryza glaberrima*. In the deep flooding areas floating varieties are required and the object of the improvement programme is to select high yielding, white grained floating varieties of *Oryza sativa*, with a vigour and flood resistance comparable with the indigenous floating varieties of *O. glaberrima*.

Regional trials.—The evaluation of floating varieties in observation plots at Birnin Kebbi, the Jere Bowl, Hadejia, and Illushi continued. At Birnin Kebbi the highest yielding varieties were Mali Ong, Bais-Bis and Indo Chine Blanc. Mali Ong was also the highest yielding variety in the observation plots at the Jere Bowl ; these plots were severely damaged by birds and the trial will be repeated in 1963. The flood was of longer duration than usual in 1962 and it is considered that a more early maturing variety than Mali Ong may be of more general application.

The observation plots at Hadejia were destroyed by floods which rose 6 feet in two days. At Illushi the early floating variety Bhendot T.100 was drowned after heading and only Mali Ong and Indo Chine Blanc survived the flood. Mali Ong gave its highest yield (1,200 lbs per acre) when sown in April, while Indo Chine Blanc gave its maximum yield (800 lbs/acre) when sown in May. The germination and early growth of rice in this area is rainfed. If the crop is to survive, the establishment period is critical and the rainfall in April is unreliable. Better establishment is obtained in May, but the life period of Mali Ong is too long for May planting as the floods have receded before the crop is mature. The 1962 results confirm those of 1960 and 1961 and indicate that the highest average yield over a number of years would be obtained from sowing Indo Chine Blanc or a similar high yielding, short duration, floating variety.

Inter-variety trials, Badeggi.—A new floating variety trial was commenced in 1962 in which six selected *Oryza sativa* varieties were compared with two high yielding *O. glaberrima* varieties. The trial site was deep ploughed before rotavation and this established severe reducing conditions in the soil. The varieties Indo Chine Blanc and Kra Suey were extremely susceptible to the high Eh values and failed completely. The variety Bhendot T. 100 was drowned in the flood. Both *O. glaberrima* varieties were higher yielding than Mali Ong. Tisei was as before the highest yielding *O. sativa* variety, but it is red-grained and will be discarded from the trial, which is to be repeated in 1963.

A trial to compare the effect of planting date on the life period of four floating varieties was commenced. The results were not complete at the time of writing.

A considerable range of variation in flowering date was observed within the varieties Mali Ong, Indo China 53 and Champa. Four hundred and ten individual plant selections for earliness were made in 1960 and compared with their parent stocks in 1961. Fifty-seven of these selections were planted for futher trial in 1962. Seven selections from the variety Mali Ong flowered between 14 and 21 days earlier than their parent and these were retained for further trial in 1963. All the other selections were discarded.

In 1960 the early floating variety Indo Chine Blanc was crossed with Mali Ong, Champa and Indo China 53 to produce early high yielding varieties. The F_2 populations were grown in the fadama at Badeggi in 1962. One hundred and seventeen individual plant selections were made from these bulk populations. The remainder of the material was bulked according to cross and will be tested at Birnin Kebbi.

The F_1 generation of crosses between Indo Chine Blanc with Tisei and BG 79, and between Bhendot with Mali Ong and Tisei was grown in pots in 1962. Attempts to cross Nan Ring and Indo Chine Blanc failed. Several of the new acquisitions to the Variety Collection were desirably early and they will be further examined in 1963.

In July a number of elongated plants with long, yellow, narrow leaves were noted among the floating varieties. Similarly affected plants were later observed in almost every variety in the collection. The plants die quite quickly after the appearance of the leaf symptoms. The vascular tissue of the lower nodes of the stem becomes discoloured and from these discoloured areas the microcomidia of a *Fusarium* species was isolated. It was suspected that the pathogen was *Gibberella fujikuaoi* (Saw) Wr. This is the first record of this species in Nigeria and specimens have been sent to Kew for indentification.

Interspecies hybridisation.—The species *Oryza glaberrima* is indigenous to West Africa and has a wide tolerance of environmental conditions and outstanding vegetative vigour. The Nigerian varieties of this species have two disadvantages as cultivars, they are red grained and they shatter when ripe. A breeding programme to combine the vigour and range of environmental tolerance of *O. glaberrima* with the white grain character and non-shattering habit of *O. sativa* was commenced in 1958-59 when the two species were successfully crossed together.

The F_4 generation of crosses 13, 14 and 15 were grown in the fadama in 1962. These crosses were based on the *O. sativa* variety B-type (35/55). Crosses 13 and 15 were between B-type and the *O. glaberrima* variety Kauchi (82/55). Fertility in F_4 families was generally low. Cross 15 contained a number of early families, but unless a marked improvement in fertility is shown in the F_5 in 1963 the progeny from these crosses will be discarded. Cross 14 between B-type and Kuntu (69/55), was more promising. Thirty-five F_4 families were sown. Self fertility of the families in this cross ranged from 5 to 68 per cent. Eleven families of low fertility were discarded at harvest, and individual plant selections were made to test the degree of homozygosity reached in the F_4 generation. Two families were selected for trial under deep water conditions. The F_5 of seven selected families was grown in pots during the dry season.

Thirty families of the F_3 generation of Cross 20 were grown in the fadama. The parent varieties in this cross were No. 415 (18/56) and Biya Gero (4/56). Self fertility in this family was high ranging from 35 to 82 per cent. The mean was 57.6 per cent representing an increase of 7.0 per cent over the F_3 in 1961. A number of individual plant selections was made in the F_3 in 1961. The progeny of these selections showed an increase of 117 per cent in yield

compared with their F_4 parents indicating that selection had been effective on attributes of yield other than sexual fertility. Six individual plant selections were made from the F_4. Six families were selected for test of their putative floating habit. The F_5 of ten high yielding families were grown in pots during the dry season, to enable the F_5 and F_6 generations of this cross to be compared in 1963.

Cross 29 was made in 1959 between GEB 24/37 (16/55) and Dan Bolo (65/55). One hundred F_3 families were grown in 1962. Segregation for grain colour was noted in forty families. Self fertility varied from 2 to 92 per cent and the distribution of percentage fertility in this generation was negatively skewed. Twenty-two families of low fertility have been discarded. Eighteen individual plant selections were made from 12 families to observe segregation in the F_4 generation. The F_4 generations of 31 families were grown in pots during the dry season and the F_4 and F_5 generations of this cross will be compared in 1963.

The non-inundated irrigable lowlands

The most widely grown rice variety in the non-inundated, irrigable lowlands is BG 79 originally introduced from British Guiana. This variety owes its wide distribution to its great range of environmental tolerance, but it was considered possible to select varieties for specific areas, which in those areas, would be able to outyield BG 79. The improvement programme for shallow swamp rice is therefore divided into sections designed to produce varieties for the more limited environmental conditions which occur in these specific areas. Examples of three such areas are :

(*a*) The Northern Provinces of Northern Nigeria where the duration of the rain is limited and there is no water control in the rice fields. A variety of shorter duration than GB 79 with a life period of around four months is required. Trials of short duration varieties are being carried out at Badeggi and a hybridisation programme to produce new lines has commenced.

(*b*) The Riveraine Provinces of Northern Nigeria where BG 79 is grown in areas without water control and where the water supply, either by rainfall or flooding, is adequate for a variety of five months duration. For these areas, varieties of the same duration as BG 79 when planted in July, but of greater yield potential, are being tested in Regional trials and a hybridisation programme aimed at the production of further 5 months selections will be commenced at Badeggi in 1963.

(*c*) Controlled Irrigation Schemes in the Riveraine Provinces where water is available from $5\frac{1}{2}$ to 6 months, and a variety of longer duration than BG 79 can be used. These varieties are also suitable for other areas, that is, around Abakaliki in Eastern Nigeria where the natural rainfall lasts for more than 6 months. Trials of varieties of suitable duration are being carried out at Badeggi.

Regional yield trials.—A combined analysis of the earlier main crop variety trials in the Riveraine Provinces has been carried out. From the results of this analysis, data from paddy and rice preference tests, and milling studies, Mas 2401 was recommended to replace BG 79 at Pategi and Badeggi in 1963. In both areas irrigation schemes provide sufficient water for this variety which is relatively insensitive to variation in day length. D 114 is recommended to replace BG 79 at Zonkwa. At Shendam, Wukari and Utur, none of the varieties tested were recommended to replace BG 79. D 53/37 yielded highly at Kofare, but this variety is not recommended because of poor milling quality and low protein content. D 99 is recommended for Shendam to replace GEB 24/37.

At Pategi a late season variety trial was planted to select a suitable short duration variety to follow the normal season crop. The trial was a six replication randonised block design with BG 79, and the short duration varieties Co-9, Co-13, MTU-9 and Precose. No significant

differences were found between the yields of these varieties ; Precose was the highest yielding variety giving a yield equivalent to 3,109 lb/acre, BG 79 was the lowest yielder producing 2,487 lbs/acre.

Observation plots were planted at four centres in Northern Nigeria. At Maiduguri, BG 79 was the highest yielding variety giving a yield equivalent to 2,801 lb/acre. Patnai was the lowest yielding variety producing 1,193 lb/acre. At the same site, F 3 seed of Badeggi Cross 27 (MTU-9 x BG 79) was planted to select a short duration replacement for BG 79 under local conditions. Individual plants of high yield that were ripe at the time of the local farmers harvest were selected and their seed bulked. The F 4 population from this seed will be sown for further selection in 1963.

The short duration varieties Co-13, MTU-9 Precose and Tai-Chu 65 and the long duration varieties Bolo 108, Kav 12, PTB 16 and Siam 29 were compared with BG 79 in 1961 and 1962 under the saline-alkaline conditions which obtain at Yau. MTU-9 and Tai-Chu 65 were the highest yielding short duration varieties and PTB-16 the highest yielding long duration type in the areas of highest salt concentration. Tai-Chu 65 gave a yield equivalent to 3,345 lbs/acre and PTB 16 a yield equivalent to 3,223 lbs/acre.

At Daura, the short duration varieties Tai-Chu 65, MTU-9, Co-13 and Precose were higher yielding than BG 79 and 3 other varieties. The cultural method used in 1962 differed from that in previous years and no comparison with the earlier results was made.

At Vom, the swamp variety Rojofotsy 1285 and the upland variety Agbede 16/56 were compared under semi-swamp conditions. The yield of Rojofotsy was higher than that of Agbede 16/56. Both varieties gave higher yields when grown on the flat than when grown on ridges. Nitrogen and phosphate fertilizer applications are necessary for the maximum expression of yield.

In the shallow flooding areas at Illushi, Western Nigeria, BG 79 was compared in 1961 and 1962 with five other varieties in a statistical trial. GEB 24/37 gave a significantly lower yield than any other variety in trial. Over the two years, BG 79 and MAS 2401 were the highest yielding varieties. MAS 2401 is not recommended for this area as it lodged badly in both trials. The multiplication of BG 79 for these areas is recommended.

Inter-variety yield trials, Badeggi.—A new main crop variety trial was planted in 1962 with the varieties Dissi.N.14., E.I., MTU-16, SC.308/31 and Shingo La Mjane. These varieties were compared with BG 79 and MAS 2401 in a 7 x 7 Latin square. The highest yielding variety was Shingo La Mjane which gave 2,893 lb/acre, but the yield was not significantly greater than BG 79 and MAS 2401 which were the second and the third highest yielding varieties. Differences in sensitivity in day length were shown and the life periods of the varieties in this trial agreed fairly well with those obtained from the successional planting trial. A new trial of varieties of 6 months duration was planted with the varieties Gambiaka Sebela, HM-A-6, IM.135, Sokotera, Sossoka and Sughandi C. These varieties were compared with Bolo 108 and Siam 29 as control in an 8 x 8 Latin square. The highest yielding variety was Siam 29 which gave a yield equivalent to 2,811 lb/acre which did not significantly outyield Sokotera and Gambiaka Sebela. These three varieties gave a highly significantly greater yield than the other five. The lowest yielding variety was HM-A-6 which produced 1,580 lb/acre. The life periods of these varieties when planted in early June was around 180 days, except Siam 29 which was 200 days.

The 7-month variety trial with the varieties Khao bhu dat, Khao tod long, Nam dok mai. Parn-A-191, Reyong and Seri Raja with Kav. 12 and PTB-16 as controls, was repeated in 1962, Khao bhu dat was the highest yielder with 2,109 lb/acre and significantly outyielded both controls. Seri Raja and Reyong also yielded well. The lowest yielder was PTB-16 which produced 1114 lb/acre. The yield of PTB-16 in this trial is disappointing as it had performed well in earlier Kav 12 replacement trials. The trial is to be repeated for one more year to confirm the results.

Intra species hybridisation.—During the period under review the following hybrid material was planted.

Cross No.	*Parents*	*Seed*	*Object*
1	MLY-B-402 X GENERAL ROSSI	86 F4 select. + Bulk	lodging resistance and B-grain type of 6 months duration
2	INDIAN PALIL X MAS 2401	103 F4 select. + Bulk	
3	INDIAN PALIL X No. 415	82 F4 select. + Bulk	
25	BG79 X TAI-CHU 65 ..	F3 Bulk ..	Short duration variety with B-type and high yield
27	MTU-9 X BG79 ..	F3 Bulk	
34	BG79 X MTU-9 ..	F2 Bulk	High yielding BG 79 or GEB.24/37 grain type variety of 3-4 months duration
35	G.E.B.24/37 X MTU-9	F2 Bulk	
36	BG79 X PRECOSE ..	F2 Bulk	
37	G.E.B.24/37 X PRECOSE	F2 Bulk	
38	TAI-CHU 65 X BG79	F2 Bulk	
39	G.E.B.24/37 X TAI-CHU 65	F2 Bulk	
40	BG79 X TAI-CHU 65..	F2 Bulk	

In Crosses 1, 2 and 3, new line selections within the F4 selections and the bulk material were made. Cross 3 gave the poorest performance, India Palil and No. 415 did not combine well and many of the hybrids were stunted. The hybrids from Cross 2, India Palil and Mas 2401 were much more vigorous. Line selections were made in Crosses 25 and 27. Crosses 34-40 were harvested in bulk. The influence of Tai-Chu 65 when used as male or as a female was noted. In Cross 38, most of the plants had the Tai-Chu 65 habit with the BG 79 grain type. In Cross 40, the reciprocal of Cross 38, the plants had the BG 79 habit with the Tai-Chu 65 grain shape. A similar reaction was found in Cross 25 during 1961 and 1962. These differences in the habit of the reciprocal crosses was not obvious in Cross 27 and 34. This is perhaps partly due to the less distinctive differences in habit between MTU-9 and BG79 compared with the marked differences between Tai-Chu 65 and BG 79.

Milling studies.—Thirty varieties at present in trial at Badeggi were milled following a standardised parboiling and milling technique. It was originally intended to mill each variety at 10 different moisture percentages to determine and compare the optima for the varieties. However it was not possible to dry the grain samples to a uniform moisture content, as it was discovered that there was considerable variation within individual trays in the drying

oven. It was therefore only possible to compare the mean milling quality of the varieties in the 10 samples over similar ranges of moisture content. The samples were soaked for 24 hours, boiled for 15 minutes and artificially dried at 36 to 37-C; they were hulled in a McGill sheller and milled in a McGill mill. There was a considerable variation between the varieties in milling out-turn; Khao Bhu Dat, Pokkali, PTB 16 and Toma 112 gave a mean of 3 to 5 per cent broken grain. Bolo 108, Castle Peak, No. 2 D99, Fa-Yiu-Tsai, GEB24/37, Kav 12 and Paddi Sawah III gave 7-12 per cent broken grain. BG 79, D114 No. 37 and ADT-9 were poor, giving 35 to 51 per cent broken grain.

Experiments have been commenced to determine if the parboiling treatment used in these experiments was the optimum treatment for all varieties. There are indications that some varieties give a better product when soaked for longer than 24 hours, but these experiments were not complete at the time of writing.

A survey was made of various rice mills in part of Bida Division, Niger Province. The mean moisture percentage of 41 parboiled paddy samples and that of 44 rice samples collected from different rice mills was the same, 16.06 $\pm$ 0.36 per cent. This moisture percentage corresponded with the optimum moisture percentage for the highest milling out-turn found in laboratory experiments on three sun-dried, parboiled rice varieties. The percentage broken grain in 44 rice samples was 33.09 $\pm$ 1.78.

Rice preference tests.—Rice and paddy preference tests on taste and appearance were carried out in eight centres of the Northern Region. Most of the tests included the varieties of the main crop variety trial. In four centres a significant ranking order in the palatability tests could be established. Blindfold taste tests gave no significant differences between varieties at any centre. Cooked and raw rice preference tests gave significant ranking orders in seven centres ; paddy preference tests were significant in 6 centres. Apparently taste, in the true sense of the word, was not as important as the appearance of the cooked and raw rice in deciding which varieties were preferred.

The rainfed uplands

The typical Nigerian upland varieties have a D-type glutinous grain. This grain type is of limited consumer appeal and there is an increasing demand for a high-yielding B-type replacement. *Pyricularia oryzae* and *Helminthosporium oryzae* are widespread in the areas of upland rice growing and cause severe losses of crop. The objects of the breeding programme are to produce a high yielding B-type grain with high resistance to *Pyricularia* and *Helminthosporium.*

Regional trials.—A new series of Regional trials in Western Nigeria was commenced. Two long duration upland varieties from Ceylon, Suduwee and VI 28061, had shown considerable promise in 1960 and 1961 at Irrua. It was considered that these varieties and the Nigerian variety Alabere B were of greater yield potential than the varieties Kogbandi, Oshodi and Bikom and replaced them in the 1962 trials. They were compared with Agbede 140/54, Agbede 16/56 and Jete in a 6 by 6 latin square design replicated at 6 centres. The data from the replicate at Erin Oke are not included in the joint analysis as the trial was harvested too late for any reliance to be placed on the results. The trials were all planted between the 17 to 25 April ; the average life periods were slightly longer at Ikole than elsewhere but the difference was not large enough to be significant.

There were no significant differences between the life periods of the Nigerian varieties Alabere B, Agbede 140/54, Agbede 16/56 and Jete. They averaged between 91 to 94 days to harvest. The life periods of VI 28061 (144 days) and Suduwee (126 days) were significantly longer than the Nigerian varieties. Suduwee and VI 28061 were most disappointing and proved

highly susceptible to *Pyricularia*. They failed to produce a crop at Ikole and Obior and were the lowest yielding varieties at Irrua, Ofada and Ijebu. At Ijebu-Ode and Ofada, Agbede 140/54 was the highest yielding variety, but its yield was not significantly greater than Jete ; at Obior, Irrua and Ikole, Jete produce a significantly greater yield than any other variety in trial (P=0.01). In a combined analysis of the yield data of the four Nigerian varieties at 5 centres, Jete was significantly higher yielding than the other three varieties (P=0.05). There was no significant difference between the yields of Agbede 140/54 and Agbede 16/56. Alabere B was the lowest yielding of the Nigerian varieties in trial and will be discarded. Significantly higher yields were recorded at Ikole and Ijebu-Ode than at any other centre (P=0.05). The highest individual yield was recorded at Ikole where Jete gave a yield equivalent to 2,355 lbs per acre. The results from the Nigerian varieties agree closely with those obtained from the 1960 and 1961 series of trials, and again demonstrate the overall superiority of Jete compared with the Agbede varieties.

Jete is a long awned variety with a D-type grain. The long awns give it considerable resistance to bird attack, but detract from the appearance of the grain ; long awned grain is not popular with millers. In preference tests carried out in the Benin-Delta area the long grained Agbede 16/56 was clearly preferred and commanded a higher price than either the short grained Agbede 140/54 or Jete. The price differential in favour of long grain tends to cancel out the value of the increase in yield obtained from Jete. This variety would only be distributed as an interim measure until a variety of equivalent yield and with a B-type grain is obtained.

Variety yield trials, Badeggi. To compare the results obtained in the Western Region trials with those at Badeggi the Regional trial was replicated on a rainfed site on the fadama. The results obtained at Badeggi were completely different from those from the Western Region. The incidence of *Pyricularia* and *Helminthosporium* was very low and the long duration varieties Suduwee and VI 28061 demonstrated their superior yield potential and gave a significantly greater yield than the four indigenous varieties (P=0.001). There was only a limited amount of seed of Jete available for the trial and the establishment of this variety was poor. In a covariance analysis between stand count and yield, Jete was the highest yielding of the indigenous varieties, but still much lower yielding than Suduwee and VI 28061. The trial was damaged by birds. Jete, the only long awned variety in trial was least affected. When yields were corrected for bird damage, Suduwee gave a yield equivalent to 3,138 lbs per acre. There was no significant difference between the yields of Suduwee and VI 28061, the latter giving a yield equivalent to 2,981 lbs per acre. The comparison of upland varieties on the Badeggi fadama will continue ; the conditions which obtain on the fadama permit the expression of maximum yield potential and this is of value in the selection of high yielding parents for the breeding programme.

A trial of 13 varieties was planted in the fadama and replicated on the upland site. Establishment in both trials was not good. It was possible to correct yields for stand count in the fadama trial but losses were more extensive on the upland site and the trial could not be analysed. VI 28061 was the highest yielding variety (P=0.05), PTB29, PTB29 No. 2 and Satika were all higher yielding than Suduwee.

In 1961 it was observed that some upland varieties in the collection exhibited a wide range of flowering date. Thirty-two individual plant selections were made from six varieties. They were planted in a rainfed area of the fadama in 1962 and compared with their parent varieties. None of the selections were markedly more early than their parent and they were discarded at the end of the season.

Considerable variation was observed between individual plants of Agbede 140/54. In 1960, 100 individual plant selections were made from this variety and the progeny were grown in 1961. Six progeny which represented the range of yield variation within the variety were selected and compared with Stage I material in a six replication randomised block design. Water control on this trial was not good and it suffered excessive bird damage. The coefficient of variation was very high and although the yields of selections differed by 77 per cent, significant differences could not be demonstrated. The trial will be repeated in 1963.

The same selection procedure was followed with Agbede 16/56. Eight selections were compared with the Stage I material. The trial was more accurate than the Agbede 140/54 trial. Differences in the yield of the selections of 25 per cent were demonstrated, but these were not large enough to be significant. The trial will be repeated in 1963.

The variety Jete has long awns, but occasional short awned and awnless plants do occur within the variety. Pure line selection of both awned and awnless lines was commenced in 1962. Seventeen individual plant selections were made in the field before harvest. These selections were grown in pots for two generations during the dry season. The pots were kept flooded as the character awn is most clearly expressed under water-logged conditions.

In the main, the individual plant progeny bred true for awn ; in some selections from a parent that was awnless in the field the progeny showed occasional short awns (5 mm long) on the terminal florets when grown in standing water. The awned selections showed a complete expression of the character with all grain bearing awns up to 25 mms in length. These progeny will be planted in the field in 1963.

Two collections of upland varieties were grown in 1962. 70 varieties were grown on the upland site ; Agbede 140/54 was used as a replicated control. The planting of the collection was delayed until the 12th June by the irregular rain. Varieties with a duration of greater than 150 days failed to produce a crop. The highest yielding variety was Bikom. Twelve varieties produced a greater yield than the control. At flowering time the incidence of *Pyricularia oryzae* was high. Five varieties developed stem blast after flowering and failed to produce a crop. Fifteen varieties showed resistance to *Pyricularia*, notably R66 which remained almost completely symptomless the whole season. Yields generally were low and it was decided that the upland site at Badeggi is outside the expected environmental range of upland rice. The collection will not be grown on this site in 1963, but will be replicated at three sites in the Western Region.

The upland varieties are included in the Station Variety Collection. This collection is grown under shallow swamp conditions. The upland varieties are maintained here to ensure a continuous stock of pure seed. The yields obtained under these conditions bear no relation to those obtained on the upland site. The long duration types are not limited in their growing period by the duration of the wet season and these form the highest yielding group of varieties.

The variety Agbede 16/56 contains occasional plants which are red grained. Red grained individuals have occurred in plants grown from Stage I seed and it is considered unlikely that they result from contamination, as the plants are typical of Agbede 16/56 save for grain colour. It is possible that these red grained individuals arise from the mutation of an unstable colour allele. To determine the mechanism of inheritance of grain colour in this variety, red and white individuals are crossed together. Red grain was dominant to white in the F_1 generation The F_2 will be grown later in 1963.

To obtain information on variation in, and varietal resistance to, *Pyricularia oryzae*, F.A.O. invited member countries to plant 'Blast Nurseries' in which the incidence and intensity of the disease could be studied. Conditions in the nursery are standardised and a common system is used for scoring disease symptoms. One hundred and twenty-eight varieties were

compared in a 'Blast Nursery' grown on the upland site at Badeggi. The disease did not become epiphytotic and it was not possible to compare the resistance of the varieties. The Blast Nursery will be grown in Western Nigeria in 1963 where the incidence of *P. oryzae* is higher.

Agronomy

Plant Population Studies

The results obtained from a series of experiments designed to study the yield responses of transplanted rice to variation in the size and shape of individual plant area were quoted in the last Annual Report. These results have led to the adoption in 1963 of a new standard spacing for all the trials at the Rice Research Station, namely, 36 square inches per plant, planted in rows 12 inches apart with plants 3 inches apart in the row. The yield increases to be expected from this spacing are such that it will be economical for farmers to adopt, notwithstanding the increased costs of transplanting and weeding.

The influence of the number of seedlings per stand on the yield of transplanted rice was studied in an experiment which commenced in 1961. Varieties of low, medium and high tillering capacities (Tai-chu, BG 79 and Tjina) were compared with stand populations which varied from 1 to 15 plants per stand. The experiment was repeated in 1962. In neither year, nor in the combined analysis of both trials, could a significant effect of stand population on yield be demonstrated (this is contrary to the 1962 Annual Report). There was no interaction between varieties and stand population. In the combined analysis, Tai-Chu significantly outyielded BG 79 and Tjina, and Tjina outyielded BG 79. This trial has led to the recommendation that for practical purposes 2 or 3 seedlings per stand should be planted to allow for failure of one seedling to establish. The results of the plant population studies have been summarized and presented for publication.

To combine and further investigate the results of the plant population and fertilizer trials, an experiment was commenced to study the interaction of plant density and rates of application of sulphate of ammonia. Three spacings of 6 x 6, 9 x 9 and 12 x 12 inches, and three plant populations of 2, 6 and 10 plants per stand : with four rates of N applications, 0, 2, 4 and 6 cwt of sulphate of ammonia per acre were compared at Badeggi. Unfortunately the trial was adversely affected by high floods and subsequent bird damage caused low yield and a very high experimental error. The trial will be modified in 1963 ; the stand population statements will be omitted from the experiment ; four spacings with three rates of application of sulphate of ammonia will be compared.

A seed rate and spacing trial with direct seeded rice was planted at three centres, Badeggi, Jere Bowl near Maiduguri, and Lowlands, Shendam. Combinations of three spacings and three stand populations of spaced, direct seeded rice were compared with three rates of broadcast application. The seed rates used were 30, 60 and 90 lbs per acre which occurred in all combinations with the following spacings : 6 x 6, 12 x 12, 18 x 18 inches and broadcast. The trial at Badeggi failed due to a severe attack of *Pyricularia oryzae*. At Jere Bowl, broadcast rice significantly outyielded rice seeded at 12 x 12 and 18 x 18 inches. The yield from a seed rate of 60 lbs an acre was significantly greater than that from 30 or 90 lbs per acre. At Lowlands the yield from rice at 12 x 12 inches spacing was less than that from the other spacings at a seed rate of 30 lbs per acre. At 60 lbs per acre the yields from 6 x 6 and 12 x 12 inch spacings were greater than those from 18 x 18 inches and the broadcast treatment. The overall seed rate effect was not significant. The 18 x 18 inches spacing gave a significantly lower yield than the three other spacings. Soil moisture stress occurred in this trial from 2 to 7

weeks after sowing. In October, the trial also showed severe symptoms of phosphorus deficiency and these factors are considered to be at least partly responsible for the failure of the higher plant populations to produce greater yields. The trial will be repeated in 1963 with adequate applications of fertilizer.

A plant population trial to compare three plant spacings and three plant populations with transplanted rice was laid down at the Tomas Irrigation Scheme in Kano Province in 1961 and repeated in 1962. The yields from spacings of 9 x 9 and 12 x 12 inches were greater than from 18 x 18 ; no significant difference was found between 9 x 9 and 12 x 12 inches. There was no significant difference in yield from the three stand populations in each individual year or in the combined analysis.

Nursery Technique Trial

Data from nursery technique trials carried out at Badeggi in 1958 and 1960 indicated that plants from seedlings grown for four weeks in the nursery gave a significantly greater yield than plants from eight weeks old seedlings. The result was reversed in the 1959 trials but in this year the nursery was sown six weeks later than in 1958 and 1960. Therefore a new trial was designed to study the interaction of sowing date and the length of time the seedlings are in the nursery, and also to determine whether the application of sulphate of ammonia can be used to shorten the period required in the nursery. This trial was destroyed by floods and will be repeated in 1963.

Seed Dressing on Broadcast Swamp Rice

A trial was laid down at Badeggi and replicated at Jere Bowl, Maiduguri to compare the effect of fungicidal and combined fungicidal-insecticidal seed dressings upon the growth and yield of broadcast swamp rice and on the incidence of attack by the beetle *Heterochynus sanctae, helenae*. The following treatments were used, control (no dressing) Fernasan A (Thiram), Fernasan D (Thiram+Gamma BHC 0.3%). Dieldrex B (Thiram and Dieldrin 0.3%). Unfortunately the trial was destroyed by floods at Bedeggi. At Jere Bowl, although the yield from all the treated seed was considerably higher than that from the control the differences were not large enough to be significant. A very high average yield of 4,366 lb/acre was obtained. Unfortunately the trial was not attacked by *Heterochynus*. The experiment will be repeated in 1963 at Badeggi and at Jere Bowl with inclusion of Aldrex T (Thiram+ Aldrin 0.3%) as a fifth treatment.

Mechanical Cultivation

The standard practice for preparation of the land for transplanted swamp rice at the Rice Research Station was to cultivate the land after flooding with a Howard Rotavator drawn by a Ferguson 35 tractor equipped with half tracks. This produces an admirable medium for transplanting, but rotavation is only a very shallow cultivation and it was feared that it would not control the indigenous, deep rooted perennial weeds. In the dry season of 1962 to 1963 all the fields were deep ploughed and rotavated after flooding prior to transplanting. To study the effect of mechanical cultivation on the weed flora of the fadama soils an observation trial to compare five methods of cultivation was commenced in 1961. A continuous fallow strip was left as representing the original weed population and compared with (*a*) rotavating before planting (*b*) deep ploughing after the rice harvest every year with annual rotavation (*c*) deep ploughing every two years with annual rotavation before planting and (*e*) deep ploughing after harvest every year followed by disc harrowing before planting after the top growth of the weeds has been removed by hand. The composition of the weed flora is determined each year before irrigation and cultivation, and after harvest, by rank frequency method. The weeds pulled out with the weeding during the cropping season are sorted in species and their fresh weight determined. The results of this trial are not yet complete.

Cattle Cultivation

To investigate the possibility of developing a mixed farming system based on rice, two Zebu bullocks were acquired and were trained to work in flood fields. Of the implements tested (ploughs, harrows and weeders), the Emoot Victory single furrow mould board plough was found to work quite well. Unfortunately one of the bullocks contracted trypanosomiasis and never really recovered. This made testing of the implements difficult because of the uneven strength of the animals. Moreover the lack of trained labour capable of handling cattle was another serious drawback. The two bullocks have now been sold and further work is suspended until staff becomes available to concentrate on this problem.

Crop Water Requirements

To study the pattern of water uptake in partially rain fed rice four shallow tanks have been constructed. Plants were sown at four seed rates to follow the water consumption of different plant populations under simulated semi-dry conditions which exist in some parts of Northern Nigeria. The growth and development of the plants was also studied. The data from these experiments had not been analysed at the time of writing and the work is being continued, together with a pot experiment to study the influence of phasic soil moisture stress on the growth rate of rice.

The lysimeters have been constructed and installed in the fadama to study the water consumption of rice compared with evaporation from a free water surface. Work with the evapo-transpirometers, radiation measurement and standard meteorological observations has been continued to obtain data for a production of suitable evapotranspiration formulae for irrigated and semi-dry land rice. The soil-moisture extraction patterns of dry season crops grown on the fadama are being studied. Dry season cropping has a beneficial effect on the following rice crop (see crop rotation studies below) and if successful would enrich the rice farming community and diversify its economy.

Crop Rotation Experiment

A programme of investigation was commenced in 1960 to select legume crops able to grow in fadama soils during the dry season without supplementary irrigation. The leguminous crop may be used as green manure, cattle food and/or as a source of grain legumes for human consumption. A collection of legumes was screened in observation plots in the dry season of 1960 and selected species were put into a randomised block trial on the fadama in the beginning of the dry season in 1961. The selected legumes were *Stylozanthes gracilis*, *Crotolaria juncea*, *Crotolaria retusa*, *Dolichos lab lab* (2 *var.*), mixtures of *Centrosema pubescens* with *Sesbania macrocarpa* with *Calogonium mucunoides*. Three additional treatments were included : the application of 5,000 lbs straw per acre, *Penisetum purpureum* as a crop and a natural fallow. All the plots were split for rates of application of superphosphate at nil and 1 cwt per acre. Growth was disappointing compared with the observation plots of the previous year, probably due to the very low water table which resulted from the low rainfall in 1961. With the onset of the rains in 1962, growth improved and differences were visible between the fertilised and unfertilised sub-plots. Hardly any seed set occurred and the green material was cut and turned in at the end of June ; the field was then flooded. Rice was planted as test crop one month later and at harvest clear green manuring effects were found from *Stylozathes gracilis*, *Crotolaria junceae* and the *Calopogonium : Sesbania macrocarpa* mixture. The application of rice straw significantly depressed the rice yields. On all the treatments, with exception of *Penisetum purpureum*, the application of superphosphate at the beginning of the dry season had a remarkable effect in increasing the yield of the rice crop. This effect was especially spectacular in the fallow treatment where a rice yield increase of 56 per cent was obtained by

applying the superphosphate. Soil samples taken before and after the rice crop are being analysed for total nitrogen, ammonium on and nitrate ion. The same treatment were planted again in the dry season of 1962-1963 and the plots were split for nil and 2 cwt of superphosphate. A cowpea variety trial, planted mid-January 1962 yielded poorly because the soil was already too dry after the early cessation of the rains in 1961. Yields recorded for the following varieties were in lbs dry beans per acre : New Era, 136 lbs ; Giant Blackeye, 104 lbs ; Yuwa, 184 lbs ; Ex Kirua, 148 lbs and Brabham Victor 35778, 96 lbs. There were many vacant stands due to poor establishment but unfortunately no stand count was made and it was not possible to carry out a co-variance analysis. The trial was repeated in early 1963 but complete data were not available at the time of writing. Work on green legumes in the dry season will be continued and expanded with green gram *Phaseolus aurus*, soya beans *Glycine maxima* and Black Gram *Phaseolus mungo*.

Upland Rice Agronomy

In 1961 and 1962 severe chlorosis occurred in young rice plants grown on the upland collections planted early in the season at Badeggi. The chlorotic plants occurred in irregular patches over the field and chlorosis did not appear to be a function of variety. Two trials to investigate the possible causes of chlorosis were planted in September.

Sulphur, lime and dug-in fresh grass were used to change the soil pH and fungicidal and insecticidal seed dressings were tested. Seedling chlorosis did not occur in these trials.

Applications of sulphur at a rate of 70 lbs per acre decreased soil pH from 6.04 to 5.80 and resulted in increases of fresh weight of 20 per cent in nine week old seedlings ; applications of lime at 0.8 tons per acre resulted in a 20 per cent decrease in fresh weight. The digging-in of fresh grass also caused a reduction in the fresh weight of seedlings and produced a greater increase in soil pH than the applications of lime. Seed dressing with Fernasan A, Dieldrex B and Dieldrin dust significantly reduced the mortality of young seedlings.

Studies on Weed Control in Rice Fields

In February 1962, M. Vaillant, a visiting expert under the F.A.M.A. Scheme commenced work at the Rice Research Station. His programme consisted of a study of weed control by the use of herbicides, by the modification of indigenous farming practices and by the introduction of new implements. He established an herbarium of the rice weeds of Nigeria. In April and May 1962 M. Vaillant toured Rice Research Stations in Madagascar, Senegal and the Ivory Coast to study local methods of rice cultivation and to consider the application of these methods to Nigerian conditions.

The weed flora on the Edozihgi and Chanchaga fadamas is typical of similar areas in the Riveraine Provinces and in the rice fields at Abakaliki. It differs from the weed flora of the rice growing areas of the far north of Nigeria. These areas are deeply flooded and experience a long dry season and are typified by *Echinochloa stagnata*, *Oryza Barthii* and *Vetiveria*. However, many species are common to all areas, for example, *Jussiaea*, *Sphenochlea Schyzahyrium*, *Rigitaria* and *Leersia*. Land to be used for herbicide trials was selected on the fadamas at Edozihgi and Chanchaga and bunded into 1/40th acre plots.

At Edozihgi and Chanchaga it was necessary to compare the growth of weed flora on land which is cultivated during the dry season and land which is not. Where the land is cultivated in January the growth of annual and perennial weeds is stopped. Perennials subsequently regrow from underground rhizomes in March and April. Annuals commence germination in late May and June, frequently after the rice has been transplanted.

Where the rice fields are not cultivated in the dry season the survival of the flora depends upon the amount of available soil moisture and the severity of the harmattan. The most drought resistant species are *Hyptis brevipes*, *Alternanthera*, *Fimbristyllis*, *Oldenlandia* and *Stachytarpheta*. The regrowth of perennial weeds on uncultivated land does not commence

until May or June. The annual weeds germinate after cultivation, when the rice has been transplanted. It was necessary to time the application of herbicides to coincide with the growth of the different weed species.

In June, MCPA (2-methyl, 4-chloro phenoxy acetic acid) was tested as a pre-emergent spray on the Edozihgi fadama using 0.75 to 1 litre/acre of 40 per cent solution in 60 gallons of water. At this dilution MCPA was of no value in killing either annual or perennial weeds and had no residual effect. ATA (aminotriazole) at dose rates from 7.5-10 lb/acre, was tested at Chanchaga. ATA checked the growth of *Fuirena* and *Oryza Barthii*, but it was subsequently leached from the soil and both species recovered after four weeks and growth commenced again. Transplanting began on the local farms in June. It was noted that the early transplanting was frequently handicapped by lack of irrigation water and by the strong regrowth of perennials. Weed control in later transplantings in July and August was easier and more efficient. The later the land is made up into heaps the greater has been the percentage germination of annual weeds and the more complete the kill. Also the perennial weeds are easier to control when irrigation water is plentiful.

In July pre-emergent treatments with ATA and Dalapon (50 per cent sodium salt of Dichloropropionic acid) were commenced. Dalapon was used at 20-30 lbs per acre, applied as a spray in 60 gallons of water. At both Edozihgi and Chanchaga, Dalapon gave complete control of *Oryza Barthii* and *Leersia hexandra*. Rice was transplanted five weeks after spraying and even at high levels of application no damage to the rice was recorded. 5 per cent loss of seedlings was recorded when transplanting was attempted three weeks after spraying.

Post emergent trials with P.C.P. (12 per cent sodium pentachlorphenol), Stam F.34 (36 per cent 3.4—Dichloropropionanilide) and MCPA were commenced in August. PCP and Stam F.34 are contact selective weed killers. PCP was used at rates up to 100 lbs/acre and Stam F.34 at up to 6.4 litres acre. They both gave an excellent kill of young *Cyperus difformis*, *Jussiaea* spp. and dicotyledonous weeds. They had no effect on the perennial grasses, established dicotyledons or Cyperaceaa. Both showed a marked residual effect up to four weeks after application. It was shown that the optimum time of application was within 8-13 days of transplanting or sowing. Even at the very high maximum dose rates employed there was no damage to the rice. MCPA injured the rice, even at a dose rate as low as 200 gms/acre, where it stopped growth and reduced tillering. It produced a good kill of *Cyperus* and dicotyledons but was without effect on established dicotyledons and perennial grasses.

In September several compounds were tested as pre-emergents to investigate their effect on graminaceous weeds. TCA (sodium trichlor-acetate) formulations, that is, Varitox and 2-4D compounds such as Fernoxone and Trioxone were without effect on perennial weeds even when their application was combined with hand cultivation. Combined applications of these compounds were no more effective. Experiments were also carried out with Simazin and it was shown that applications of up to 8 lb/acre applied on wet soil will check the growth of *Oryza Barthii* and *Leersia hexandra*. The solubility of Simazin is low and it is leached very slowly from the soil ; it is therefore necessary to hand cultivate before transplanting rice to bury the Simazin and expose the deeper roots of the weeds to its action. Rice can be transplanted 4 weeks after application. Simazin gave good control of perennial weeds but had no residual effect on the germination of annuals. Little improvement was obtained from mixture of Simazin and Fernesta, and Simazin and TCA.

These experiments will continue in 1963 with particular reference to substances such as Atrazine, a substituted Simazin compound which has increased solubility and is therefore more easily leached in the soil. It is thus brought into contact with the deeper roots of perennials and removed from the rooting zone of rice without the need of an additional cultivation. September applications of ATA applied at 8-10 lb/acre and of Dalapon at 10 lbs per acre was found to give a good control of the perennial weeds. No clear improvement resulted from the application of mixtures of ATA or Dalapon with 2-4D compounds.

Fernesta was found to give good control of *Echinochloa pyramidalis* if it was cut back before spraying. The effect of Fernesta on other perennials was increased when the plots were dug over two weeks after spraying.

A summary of the herbicide trials at Edozighi leads to the following conclusions. The most important weeds of rice are the perennials. From the 1962 series of trials the only chemical method of control of perennial weeds that can be recommended is a pre-planting or a pre-sowing treatment, which consists of cultivating in January, to stimulate an early regrowth of the perennial weeds in March and April, followed by the application of 17-21 lbs of 2:2 sodium dichloropropionate in the last week in April. Dalapon is recommended (50 per cent a.i.) and two other products Gramevin and Alatex (85 per cent a.i.) would also be suitable. The herbicides are best applied after rain so that both soil and leaves are wet ; they should be applied made up in 80 gallons of water per acre. The ground is then cultivated 7 to 15 days after spraying to bring the herbicide into contact with deep roots of the perennials. This must be done when the soil is wet, as, if the soil is dry, the effect of the herbicide is delayed or reduced. The land can then be puddled 4-5 weeks after spraying and the rice transplanted. No residual effect of this herbicide has been observed on the rice. The treatment should be carried out for two seasons and the field bunds should be sprayed at the same dose rate. The following species are killed by this treatment *Oryza Barthii*, *leersia hexandra*, *Echinochloa pryamidalis*, and *Ipomea*. *Leptochloa* has proved resistant to all herbicides so far tested.

In observations on the modification of cultural practices in rice growing, planting methods, fertiliser application, herbicide treatment and weeding techniques were compared. The highest yields were obtained from plots where the rice was sown in rows and then weeded between the rows with a Japanese hoe. This treatment gave a higher yield than when rice was transplanted or sown in rows and then hand weeded or when given a herbicide treatment followed by hand weeding.

The Japanese hoe gave good weed control when used in rice sown in rows 10-12 inches apart. It must be used when the ground is soft and preferably with standing water on the soil surface. Weeding with a local hoe requires 10-12 man days per acre whereas the Japanese hoe requires 5-6 man days per acre. It is necessary to weed twice or three times with the local hoe while only one weeding is required with the Japanese hoe which is followed by a hand weeding in the rows. When a local hoe is used the minimum spacing of the rice is 12 x 12 inches, that is, 43,500 plants per acre. With the Japanese hoe, plant populations up to 87,000 plants per acre can be effectively weeded. Spacing experiments at Badeggi have shown that the optimum yield of rice is obtained from a unit spacing of 6 square inches per plant and therefore it is suggested that if the rice is sown in rows 12 inches apart with plants 3 inches apart in the rows this will permit the combination of optimum plant density with the most efficient cultural practices.

The control of the water level in the fields is essential for efficient weed control. Some annuals, for example, *Cyperus* spp. and *Jussiaea linifolia* are checked by 4 to 6 inches of water, but aquatic weeds and perennials must be controlled by dry season cultivation and by chemical treatment. However, weed control cannot be considered by itself. The use of herbicides, which may cost up to £6 an acre, requires, for its justification, an advanced technique in rice cultivation with the provision of adequate water control and the use of fertilisers. Effective weed control is essential for the continued improvement of rice growing technique.

Experiments will be continued in 1963-64 to investigate further the use of the Japanese hoe together with the use of herbicides.

CHEMISTRY

Rates, methods and timing of fertilizer applications on transplanted shallow swamp rice

In 1957 and 1958, a series of fertilizer trials was commenced at Edozighi to determine the optimum rates of application of ammonium sulphate and superphosphate on three selected soil types, two of which were representative of the major rice growing areas of the Kaduna and Niger flood plains. The soil types were a Kurmi soil, which is a heavy, peaty clay containing 16 per cent organic matter ; the Badeggi series, a clay like soil, ranging from very clayey sand to clay loam or sandy clay with clay content increasing with depth, and the Mawogi series, a brownish grey sand up to about 10 inches passing into a grey, sandy clay with a compact, fine, sandy-silty layer of variable thickness usually occurring about 20 inches below the soil surface. The rates of application tested on the Kurmi and Mawogi series soils were 0.65 and 134 lbs/acre of N in the form of sulphate of ammonia and 0.57 and 108 lbs/acre of P_2O_5 in the form of single superphosphate ; 0.45 and 90 lbs of N per acre and 0.36 and 72 lbs of P_2O_5 were tested on the Badeggi series soils. These rates were compared in all possible treatment combinations. In 1959, the main treatment plots were split into two sub plots, one receiving nil and the other 67 lbs/acre of K_2O in the form of muriate of potash. In previous years, significant increases in yield were demonstrated from applications of sulphate of ammonia on the three soil types although the responses were of different magnitude.

Results of the chemical analysis of soil, straw and grain samples, collected after harvest in 1961, were used in 1962 to estimate the percentage of applied N and P_2O_5 that were absorbed by the crop. The calculated absorption percentages were used to demonstrate the relative efficiencies of N and P_2O_5 applications on two of the three soil types. The results of the Kurmi soil are omitted from the discussion because the water management on this site in 1961 and 1962 was highly unsatisfactory and the yield and uptake figures cannot be considered representative of this soil type under proper management conditions. The absorption percentages for the different N levels on the clayey Badeggi series (C.E.C. 9-10 m.e.q./100 gms oven dry soil) were rather low (about 18 per cent) and very low on the sandy Mawogi series (C.E.C. of 3.75-2.48 m.e.q./100 g oven dry soil). Both rates of crop absorption are most unsatisfactory, as up to 40 per cent recovery is considered feasible. However the utilisation of the absorbed N (75 lbs paddy/lb N) was very good on the Badeggi series and satisfactory for the Mawogi series (47 lbs paddy /lb N).

Nitrogen is easily leached from these soils, as is shown by the fact that applications of sulphate of ammonia over the last five years have brought no increase in soil nitrogen. However it is considered that the crop absorption rates could be greatly increased by the improvement of placement methods and timing of the applications of sulphate of ammonia. Deep placement of the first application during the pre-planting cultivations or localised placement shortly after transplanting would minimise losses due to nitrification and subsequent leaching of nitrate. The peak period of absorption of nitrogen is reported to be at the stage of initiation of the flower primordia, some thirty days before heading. By a careful timing of the second application, a higher absorption rate might be obtained. Crop samples, collected at the various development stages on the same experiment in 1962, are being analysed to provide more information under local conditions.

A field experiment to study the optimum time of application of the second dose of sulphate of ammonia will be laid down in 1963. Unfortunately, in local farming practice, the peak period of nitrogen requirement before heading frequently corresponds with heavy rains in the later half of the wet season ; where irrigation is not controlled the run off from the rice fields is high, and without adequate water control after the application of sulphate of ammonia much of the nitrogen may be lost.

When 36 lb of P_2O_5 per acre was applied, a small, but economical, response in paddy yields was found on the Badeggi series. This only proved significant when N was not applied at the rate of 45 lbs/acre. The absorption percentage of P_2O_5 at these two N levels (14.2 per cent) was good. However the utilisation of P_2O_5 taken up is low (42 lbs paddy/lb P_2O_5 absorbed indicating that the soils are not truly phosphorus deficient. They might become so, however, after a number of years of continuous cropping.

This is illustrated by the amount of phosphorus available in the soil after the 1961 harvest, that is, after five years continuous cropping. Plots receiving no superphosphate contained 11.0 p.p.m., and were almost deficient in phosphorus. Plots receiving superphosphate at a rate equivalent to 36 lbs/acre P_2O_5 contained 13.4 p.p.m. available phosphorus, which is adequate for crop growth and plots receiving 72 lbs/acre P_2O_5 contained 19.0 p.p.m. and had built up a considerable reserve over the five years of the experiment.

Experiments on the Mawogi series showed very low absorption percentages of P_2O_5 when applied at 54 and 108 lbs per acre in the absence of N applications. When N was applied at 65 lb/acre the absorption of P_2O_5 dropped to virtually nill. With an N application of 134 lbs the absorption increased to between 6.5 and 6.9 per cent. The utilisation percentage of the P_2O_5 taken up at the high N rate was still low, $\pm$ 20 lbs paddy/lb P_2O_5. The absorption percentage of P_2O_5 at the lower and hardly economical N level did not indicate the need for phosphorus fertilization on the sandy Mawogi series.

Although the soils showed a low potash content (0.05 m.e.q. per 100 gr. dry soil for the Badeggi series) no response to potash applications could be detected. The straw and grain samples collected in 1961 showed an overall high K content of 3.2 per cent and 0.354 per cent. This is possibly due to the high K—content of the irrigation water. Samples of irrigation water were collected at the Edozighi irrigation scheme, from the Niger and Kaduna river and in the Jere Bowl. These samples contained an average of 3.3 p.p.m. K, which is substantially higher than the potassium content of the irrigation water in other rice growing countries such as Japan and Thailand. It is calculated that the irrigation water from Nigerian rivers, supplies 34 lbs K per acre of rice field over the growing season and this is sufficient to support the crop.

Nutritional Studies (Dr J. Takahashi)

To obtain preliminary information on the variation in the nutrient requirement of shallow swamp rice varieties, ten selected varieties were grown at Badeggi in 1962. Samples of grain and straw were collected at harvest and their nitrogen, phosphorus and potassium contents determined. From the analysis of the grain, a range of variation in nitrogen content between varieties of 30 per cent was demonstrated. The maximum occurred in Makalioka 823 and the minimum in D114. The phosphorus content showed a variation of 36 per cent between the maximum in D114 and the minimum in Mas 2401. The potassium content gave a variation of 31 per cent between Siam 29 and Mas 2401.

The contents of nitrogen, phosphorus and potassium of BG 79 occurred mid way in the range of variation of the ten varieties. BG 79 shows the widest range of environmental adaptability. High nutrient content obviously reflects a high demand for the nutrient concerned but a low content of any one element may be caused by variety being unable to abosrb enough to meet its particular requirement. This may be a measure of adaptation to environment. The inter-relation of theoretical demand and actual uptake will be studied in a variety fertilizer field experiment in 1963.

In 1961 a condition known as "leaf bronzing" occurred widely in shallow swamp rice at Badeggi. Affected plants turned a light golden brown after tillering and their growth was severely checked ; these plants subsequently recovered but the cause of leaf bronzing was not known. It did not appear to be associated with any pathogenic organism.

In 1962 a field trial was planted at Badeggi to investigate the effect of changes in a soil pH on the occurrence of leaf bronzing. Applications of lime of up to 5 tons per acre produced no significant response. It was considered that bronzing might be caused by the occurrence of excessive reducing conditions in the soil. The use of uncomposted rice straw as a manure frequently establishes reducing conditions in the soil. In Japan this effect is ameliorated by the addition of soil containing a high content of oxidised iron. A pot trial was set up to investigate the occurrence of leaf bronzing in soil in which reducing conditions were established by the addition of rice straw ; the possible ameliorative effects of applications of laterite were also investigated. In the first month after transplanting, growth in the pots incorporating straw applications was significantly retarded, but with the onset of the rainy season these plants recovered and eventually produced a significantly higher yield than the untreated controls. These increases were due to increases in mean panicle weight. However "bronzing" did not occur, even when growth was stunted, and thus there was no observable effect in the laterite treatments and the experiment was inconclusive on this point.

Meteorological Data for Federal Rice Research Station—Badeggi 1-4-62–31-3-63

Month	*Rainfall (in.) Badeggi*	*Average Rainfall (in) Bida 34 Years Av.*	*Mean Relative Humidity % 090D GMT*	*Max. Temp.*	*Min. Temp.*	*Mean Temp.*
April ..	1.74	3.94	64	97.0	76.3	86.7
May ..	2.87	5.88	74	91.5	74.1	82.8
June ..	6.50	7.29	79	87.7	72.6	80.2
July ..	3.79	7.84	81	87.5	73.1	80.3
August ..	11.30	8.08	82	85.0	72.6	78.8
September ..	8.91	10.14	81	86.1	73.0	79.6
October ..	6.21	4.33	78	88.9	73.0	81.0
November ..	1.71	0.32	77	91.5	73.3	82.4
December ..	0.00	0.08	64	93.5	66.5	80.0
January ..	0.00	0.23	61	94.1	63.0	78.6
February ..	0.05	0.27	67	97.8	72.1	85.0
March ..	0.94	1.02	47	98.0	71.6	84.8
Total ..	44.02	49.42	—	—	—	—

FEDERAL ROOTCROP RESEARCH UNIT

Development of the Station

During the past year it has not been possible to implement the building programme for the Federal Rootcrop Unit at Umudike as the planning has not been completed for the overall expansion to the Regional Station. It is hoped that building will begin later in 1963.

Negotiations are still in progress for the acquisition of land for the Research Unit, and it now remains for the survey to be completed and official notification made of the land to be acquired before formal entrance can be made.

An improvement in the staffing of junior grades has strengthened the team, particularly at selection centres Mokwa, Ibadan and Benin. The Specialist Officer (Plant Breeder) has resigned from the department and it is hoped to replace him, at an early date, by a trained Nigerian Officer.

In general the staff shortage has necessitated a reduction in the programme of work and much of the breeding programme has had to be reduced or temporarily discarded. Nevertheless, encouraging results have been achieved and it is hoped to maintain the good rate of progress.

YAMS

Selection

Collections of varieties of the main economic species from within Nigeria are multiplied at Umudike and selection centres. When there is sufficient material available these varieties are placed in variety yield trials at the selection centres and out-stations. This work has been in progress for four years and useful results are now becoming available.

Variety Trials

At Umudike, in the nine variety trial of white yam (*Dioscorea rotundata*) two local varieties gave the highest yields of 5.9 and 5.2 tons per acre. A further variety trial has been planted including ten varieties which have given yields greater than 5 tons per acre in previous trials.

Six varieties of yellow yam (*D. cayenensis*) were tested for yield ; three varieties gave yields greater than five tons, one variety yielding 8.6 tons per acre. Three low yielding varieties have been discarded and replaced by varieties which have shown good potential yielding ability.

One variety out of the eight tested of water yam (*D. alata*) gave satisfactory yield (6.4 tons/acre). The low yields amongst the other varieties were due to a die-back caused by an unidentified fungus. Variety trials on this species have been discontinued at this station because of the severity of the attack by this pathogen. A trial is being carried out to determine whether the disease can be controlled by spraying.

The cluster or trifoliate yam (*D. dumetorum*) is only of local interest, and work has continued on this species to ascertain its yielding potential. Six varieties were placed under trial and all gave yields greater than 6 tons per acre, the highest being 7.7 tons. Tubers from each variety were tested for acceptability. It was found that out of the six tested, two were of the sweet type, and the rest bitter, the sweet types being the lowest yielding varieties of those tested.

Samples of the bitter and sweet types of tuber have been analysed by Professor Bevan at University College, Ibadan. He observed that all bitter tubers contained *dihydro-dioscorine*, a convulsant alkaloid (Nature, 1956 ; 177 : 935). Professor Bevan has found that all bitter yams yams contain between 0.04 and 0.1 per cent of this alkaloid and in this concentration the tubers are toxic.

Seven varieties have been included in a variety trial this year to determine the highest yielding sweet variety.

Collection and Multiplication

In the collection and museum plots a total of 400 varieties of the four economic species are under observation for growth and yield characters. Many varieties show promise of high yield. These varieties will be tested under statistical field conditions when sufficient material becomes available.

Breeding

It has been found from earlier investigations that in flowering varieties of yam, shade had no effect on flowering ; but increased sett weight would hasten the time of flowering because of earlier germination of the heavier setts. Also, it has been observed that setts cut from the head of the tuber germinate earlier than those setts taken from the middle or bottom of the tuber.

An experiment has been conducted to observe the effect on flowering and yield of different sett types planted in March, April and May. Three varieties were used, two flowering and one non-flowering variety.

It was found that planting in March gave an increase in flower production ($P=0.01$) over the other two planting dates. Although there was a larger total number of flowers produced by head setts, irrespective of planting date, over the other two sett types the difference was not significant. One variety was superior in flower production ($P=0.01$)

In respect of yield, March planting gave a significantly higher yield over May ($P=0.05$), but not over April planting ; head setts gave higher yields than setts cut from the middles or bottoms of the tuber irrespective of planting dates ($P=0.01$) ; a significant difference in yield was noted between varieties.

The effect on flowering of different varieties and different sett weights was studied, but in this case planting was done at the same time, early March. The sett weights used were 8, 12 and 16 ounces.

It was observed that some varieties produced more flowers than other varieties (an inherent character) and that 16 ounce setts produced a higher number of flowering stands than other sett weights. Sixteen ounce setts gave higher yields than 8 ounce ($P=0.05$) but not than 12 ounce setts. There were significant differences between varieties ; two varieties gave calculated yields of 13.5 and 13.7 tons per acre.

Previous experiments have not been successful in determining the best method of bagging the flowers of yams. The flowers of yam are contained as a spike in florescence, and because of their fragility are very difficult to handle. Bags, seven by two inches were made from viscous film (cigarette wrapping) ; thin gauge polythene ; thick gauge polythene ; thick gauge polythene with a butter muslin insert. Spikes were bagged at different stages in their development and controls were also set up. It was found that the thick gauge polythene with muslin was greatly superior to other materials, flower development was not hampered, but in some cases enhanced by the use of this material. Flowers bagged after fertilization developed normally. This experiment is to be repeated and attempts at cross pollination will be made.

Classification

During the growing season and after harvest the morphological characters of sprouts, vines and tubers were completed for *D. rotundata* and *D. cayenensis*. It is hoped to complete, in the near future, the key to seventy varieties of the first and sixteen of the second species.

Storage

It is known that during storage the tuber of yam respires and a loss in weight is observed ; this is due to the loss of dry matter and moisture, the latter being lost in the equating of the internal moisture content with the external relative humidity. Ten tubers from six varieties of each of the three species—white, yellow and water yams—are being observed for weight losses from harvest until July, a period of eight months. This will give some indication of the weight loss for each variety and its keeping quality. It is hoped to carry this investigation a stage further and determine whether a relationship exists between storage ability and dry matter content.

Outstations : Ilora

Variety trial.—Nine selections of white yam from Ibadan were tested against a popular local variety. For the second year in succession this local variety has proved superior to Ibadan selections. It would appear that the selection from Ibadan which are of the long tuber type are not as suited to the Ilora soil conditions as the local which are of the round type. Further collections and selections are being made for the round type of tuber.

Six varieties of water and yellow yams were tested separately in yield trials. Three varieties of water yam gave satisfactory yields of over five tons per acre, the highest yield recorded being 6.7 tons. The highest yield for yellow yam was 4.9 tons per acre and this is not considered satisfactory ; in the previous year similar low yields were observed and it is therefore considered that Ilora is beyond the climatic limit for this species which requires a longer growing season than other species.

Benin

Variety trial.—Of five local varieties of white yam tested, the yields were very good, the best variety giving a calculated yield of 10.3 tons per acre ; all six varieties gave yields greater than 7 tons. Yam beetle attack was not severe except on one variety where 21 per cent of the tubers were attacked. In three varieties 20 per cent of the tubers of each variety were unmarketable because of disease. It is thought that infection was predisposed by the tubers being left in the ground after maturity when there was still considerable rainfall. A yield trial of local varieties has been included in the programme for this year.

Agege

Collections.—The yields in the collections were low of the three species white, yellow and water yam. This is the second year of low yields at this station for white and yellow yams ; the low yields of water yam is attributed to the die-back disease which attacked the plants in July. The low yielding varieties have been withdrawn and will be replaced by further selections in future trials.

A time of planting—variety trial using water yam has been planted this year to study the effect of time of planting on the severity of disease attack.

Middle Belt

Variety trials of white yam which had more than four or more replications have been harvested from Yandev, Kabba, Kwali, Ochanja and Ilorin ; fewer replicated trials were harvested from Jalingo, Osara and Lafia. At all stations, except Jalingo, many varieties gave yields greater than 5 tons per acre, and in some cases twice this yield was recorded. These high yielding varieties have been included in further trials to confirm their performances.

Ibadan

Collection and multiplication.—At Ibadan, the main work has been the multiplication of varieties of all species for trials in Western Nigeria, and the collection of varieties for future work. This year variety trials of the white, yellow and water yams have been laid down ; ten, eight and ten varieties respectively have been used.

Agronomy

Staking trial.—In Ilorin Province the normal farming practice is to use the haulms of guinea corn as support for the yam vines, but with this method a great deal of labour is required for maintenance. It is generally agreed that higher staking gives improved yields. A trial was carried out to investigate the effect on yield of no staking, 2, 4 and 7 foot staking, and also to study the economics of using wooden stakes as trees are scarce in this area.

It was found that there was no significant difference between the treatments ; the mean yield of the experiment was 8.6 tons. Because of this result this experiment is being repeated at Ilorin, Ibadan, Benin and Umudike ; the no-staking treatment is not included at stations other than Ilorin.

Germination and yield trial.—It has been observed that the germination of setts will not occur until there is adequate rains for the sett to absorb water for the initiation of growth. It is thought that if water could be supplied sufficiently early to the tuber, then germination would begin and the new plant would be able to utilise the first rains for growth without the delay of germination. In the experiment carried out last year it was decided to soak the setts in water for twelve hours before planting. The following treatments were applied : the setts were cut and soaked ; the tubers were soaked then cut ; and in the third method there was no soaking (control). Three times of planting, in March, April and May were used and different sett types ; head, middle and botton setts.

Soaking had no effect on the germination of yam setts and this was probably due to the early and frequent heavy rains which were experienced last year. However, it was found that Mid-March planting was superior to May planting ($P=0.01$) and April planting to May planting ($P=0.01$) ; furthermore, head setts were superior to middle or bottom setts ($P=0.001$). The interaction between planting dates and sett types was significant at ($P=0.001$).

Sett weight spacing trial.—Farmers plant yams at varying spacing distances depending on the soil type and climate, and they also use a wide range of sett weights for planting. The sett weight depends on the species and whether they wish the yams to mature early or with the main crop. Some attention has been paid to this in the yam work at Moor Plantation. A range of sett weights from 4 to 20 ounces has been used at planting distances of 2, 3, 4 and 6 feet on the standard 3 foot ridge. The same design has been used for both water and white yams.

The following points have arisen from the two years experiments and they apply equally to both species.

(1) Increasing the spacing distance decreases the nett and gross yield but increases the average weight per tuber.

(2) Increasing the sett weight increases the earliness of germination, total germination, number of tubers per stand, average weight per tuber and the nett and gross yields.

Further investigations into the effect on yield of varying the inter-and intra-row spacing are being carried out at Umudike. *Ridge type trial.* The standard ridge employed on a large number of government farms is put up by a mouldboard type ridging body. At 3-foot spacings the ridge put up by this type of implement is steep sided, pointed and compact. For all root-crops a friable soil is required which will facilitate growth and penetration of the root, and this is particularly important for yams. In addition, a looser type ridge might well assist in water conservation, and hence resist erosion more effectively than the present standard ride.

In the first of these experiments at Ibadan a small trial was carried out, in co-operation with B.E.W.A.C., using a bedder disc. Ridges of 3, 4.5 and 6 feet were made. The setts were planted to give a constant area per plant on each ridge size. The result showed a superiority at 3-foot ridge spacing.

This experiment is being repeated at Ibadan and at Umudike but with modifications. At Umudike the ridges put up by the bedder disc at 4 and 6 ft were not satisfactory because the discs became clogged with trash from the newly cleared land. It has been possible to modify the implement by placing scrapers on the discs and a further modification is a centre ridge tine which cultivates the soil before the soil is thrown onto the ridge. These ridges are being compared to the standard 3 foot ridge and a 4 foot ridge made by the Gobel disc.

SWEETPOTATOES

This is the first year that the unit has attempted sweetpotato growing at Umudike. Several small scale trials were carried out as well as observations on eighty-four varieties in the collection. In general the yields were very low, except for two varieties which gave calculated yields of 3.5 and 4.6 tons per acre from small plots.

Variety Trial

Twelve varieties which had given satisfactory yields at Ibadan, that is, greater than 5 tons per acre, were tested at Umudike. The results were poor, no one variety exceeding two tons per acre. Further selections are being made for testing in the present year's experiments.

Lime v. No Lime Trial

The soils at Umudike are considered relatively acid and are, therefore, not ideal for sweetpotato growing. The effect of lime was investigated on six varieties of sweetpotatoes. There was a non-significant increase in yield on the lime plots over the no-lime plots. It is hoped to give further attention to the effect of liming in future experiments.

FIG. 4—SWEET POTATO TUBERS BEING WEIGHED AT HARVESTING
TO DETERMINE HIGH YIELDING VARIETIES

FIG. 5—FIELD EXAMINATION OF A CASSAVA PLANT ;
THIS ONE IS ATTACKED BY MOSAIC DISEASE
WHICH LOWERS THE YIELD OF TUBERS

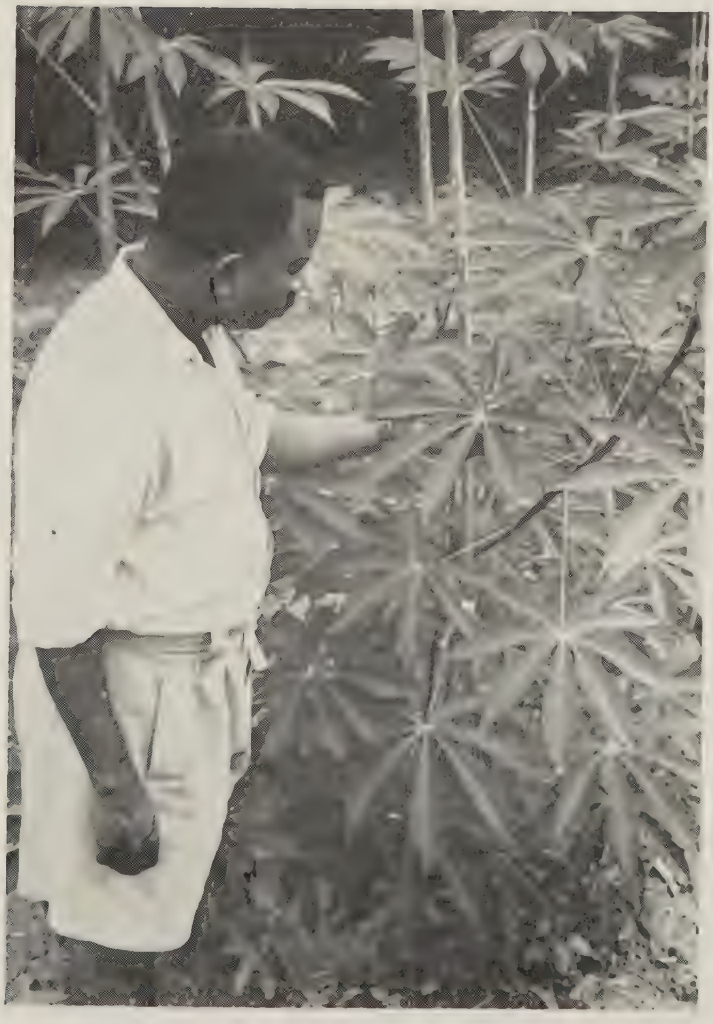


FIG. 6—FIELD EXAMINATION OF A CASSAVA PLANT
THIS IS A HEALTHY TYPE OBTAINED AS A RESULT OF BREEDING SELECTION;
THIS WILL GIVE AN INCREASED YIELD OF TUBERS

Method of Planting

A small trial was conducted to determine the best position and method of planting cuttings of sweetpotatoes. It was found that the nine-inch cutting should be planted either at an angle or vertical with buds pointing upwards and at least half of the cutting exposed.

Beds v. Ridges

The only advantage found of planting sweetpotatoes on beds as opposed to the normal practice of planting on ridges was the higher percentage of ware tubers produced. This trial will be repeated.

Breeding

Capsules of open crosses have been collected, germinated and transplanted to the nursery for the first stage of selection. Selected progenies will be yield tested under field conditions.

MOOR PLANTATION

Progeny trial. Eleven progeny from the 1961 pollination series were tested against a high yielding parent. No progeny proved itself superior in yielding ability to the parent which gave a calculated yield of 6.4 per acre. One progeny yielded 5.3 tons per acre. This trial is to be repeated.

Collections

The collections of parents and progeny are being maintained until the breeding programme is re-opened.

Cocoyams

Collections

Collections at Umudike and Moor Plantation are being multiplied for further investigations. New collections have been made from the Ikom area of Eastern Nigeria.

Cassava

Collection and Survey

A survey of cassava growing in Nigeria is being made with the co-operation of the regional departments of agriculture. The survey for the Eastern Region has been completed and is being published as a Technical Memorandum of the Department.

Local collections of varieties are being made by the staff of the Regional Agricultural Departments to provide detailed information on the available Nigerian varieties. Collections have already been received for several areas in each of the three regions. These collections will be screened for suitable botanical and agricultural characteristics and will be introduced into the Short Term Improvement Programme (Annual Report 1961-62) and into the Breeding Programme.

National Collection

The 450 varieties in the collection are being studied for their botanical characteristics as well as for their agricultural potential. It is intended to use these observations to construct a key to Nigerian Varieties.

Suitable varieties from this collection are used in the breeding programme either for hybridization or as controls in tester trials.

Multiplication and Progeny

In cassava breeding projects carried out by the Department there are four stages of multiplication and selection. In the first stage, there are 5 plant plots and at the next two stages the plant number is doubled—10 and 20 plants respectively ; the final, and fourth stage is the variety trial. Whenever planting material is available the last three stages, 2nd, 3rd and 4th, are carried out at each of the selection centres, Mokwa, Ibadan, Benin and Umudike.

Selections are made at each stage of multiplication and at each centre, for high yield combined with mosaic resistance, high yield and mosaic resistance, and other characteristics such as shape, compactness and acceptability of the tuber are also included.

1957-58 *Pollination series.* The second stage multiplication and selections have been carried out at Mokwa, Ibadan and Benin. The selections were planted in replicated trials according to one of the three selection groups. Progeny which exceeded the yield of the control and those with mild symptoms of mosaic have been selected at each station for variety trials. Nineteen progeny from Benin, twenty-one from Ibadan and fifteen from Mokwa have been selected ; nine of these varieties have been found to give a better yield than the control at the three selection centres. The remaining varieties at each station have been planted for further observations in twenty-five plant plots with three control varieties.

1958-59 *Pollination series* (*1st Stage*). Three series of pollinations were carried out in 1958 : (*a*) the study of yield inheritance (*b*) studies in segregation of mosaic resistance and (*c*) the study of protein inheritance.

(*a*) and (*b*) Selected hybrids were self pollinated, crossed with high and low yielding cassava varieties and intercrossed. Interspecies hybrids (*M. glaziovii* × *M. utilissima*) selected for their mosaic resistance were selfed or crossed with cassava varieties showing mild and severe symptoms of mosaic and intercrossed to examine the segregation of mosaic resistance.

Seventy-six progeny gave yields greater than fifty per cent of the control and three of these seventy-six exceeded the mean yield of the control. It was found that 21 progeny gave symptomless stands to virus infection and 22 showed only mild or transient symptoms, but only two of these progeny gave yields higher than fifty per cent of the mean yield of the control.

The progeny from this stage of multiplication have been planted for yield and mosaic observation plots at each of the selection centres.

(*c*) *Manihot melanobasis* contains a high protein content. A hybridisation programme was begun to investigate whether the protein content of cassava (*M. utilissima*) could be raised and thereby improve the food value (Annual Report 1958-59).

The parents and sixty-eight progeny were analysed for protein content ; the cassava parent had 1.76 per cent and *M. melanobasis* 18.47 per cent crude protein on a dry matter basis ; in the progeny the content varied between 1.23 and 6.58 per cent. The yields were generally low

but five progeny gave an eighty per cent yield of the cassava parent and one clone an increase of fourteen per cent over the parent ; this last clone had a protein content of 4.46 per cent crude protein.

The progeny are being multiplied at selection centres and observed for yielding ability.

1959-60 *Pollination series.*—A series of crosses were carried out to study the inheritance of male sterility in one intraspecies clone of cassava. The clone, a first generation progeny, was derived from a self-pollination of a high yielding variety (53101) and in the series it was crossed with two varieties which flowered profusely.

From this series 341 clones were observed and from these, seventeen clones were male sterile, sixteen of which arose from the crosses with one parent. Eighty-three per cent of the progeny were selected for future trials as they gave mean yields greater than 7 lbs per stand (11.3 tons/acre).

Selections from Amani Strains—Interspecies hybrids noted for their resistance to cassava mosaic virus—have been either selfed, intracrossed, back-crossed or crossed with high yielding cassava varieties. From these pollinations, 1,200 clones were analysed for yield and mosaic resistance. The yield was low of the clones resistant to mosaic ; 29 clones were observed to give only mild symptoms and yields of more than 4 lbs per stand (8.4 tons/acre).

It was noted that the highest yielding progeny were produced by either crossing variety 53101—a recommended high yielding variety-with the Amani strains, or by backcrossing the resultant progeny to high yielding cassava varieties.

1960-61 *Pollination series.*—No one variety has been consistently high yielding at all stations, and since the same interspecies hybrids have shown varying degrees of resistance to cassava mosaic virus under different ecological conditions, independent selections were made at Benin, Moor Plantation, Ibadan and Umudike for yield and resistance to cassava mosaic. The selections were included in the breeding programme for 1961 of which the objects were to study the inheritance of varietal characters, the inheritance of mosaic resistance and to combine together the mosaic resistance with the high potential yield of *M. utilissima* intraspecies hybrids.

The clones from these crosses will be harvested from the 1st stage multiplication later this year.

1961-62 *Pollination series.*—The hybridization was a continuation of the objects of the previous year's programme.

1962-63 *Pollination series.*—A shift of emphasis on the programme of work (Annual Report 1961-62) and the shortage of staff necessitated the reduction of a large part of the breeding programme. Pollinations were continued on those crosses which gave a low number of seeds in the previous two years pollinations.

A limited number of back-crosses were made between the interspecies F_1 hybrids (*M. melanobasis* × *M. utilissima*) and the high yielding cassava parent to study the inheritance of protein content.

Open cross isolation plots were established at Umudike which contain varieties selected for high yield, mosaic resistance and the combination of these two characters. Germination of the harvested seed is in progress.

Variety Trials

Tester trials are the ultimate stage in the selection programme. The selections for testing are made from the hybridization programme and from the collections of local material. The trials are carried out at as many stations as possible in different ecological zones. After thorough testing for yield the varieties are tested on a local basis for acceptability.

Middle Belt.—Variety trials were carried out at four stations : Yandev, Osara, Ilorin and Mokwa. Except at Ilorin, the establishment of all trials was good. At Mokwa and Yandev the yields were encouraging. Six selections at Yandev and five at Mokwa showed improved yield over the most popular local variety from each area. The highest yielding selection at Yandev gave a calculated yield of 9.1 tons per acre, and the local variety Duasi 6.9 tons per acre. At Mokwa, selection 60509, yielded 9.6 tons per acre, two tons higher than the local variety. At Osara the local variety Anaye, gave a higher but not significant yield over six selected varieties. The germination was poor at Ilorin due to drought after planting, and consequently yields per plot were low, and sensitivity of the experiment was correspondingly low ; but two selections, 60488 and 53101 gave yields greater than the local, 5.7 and 4.6 tons respectively.

Western Region.—Variety trials were carried out at Ilora, Ibadan, Agege and Akure and in the Mid-West at Effurun and Benin.

At each station the selections have considerably outyielded the local variety. In general, the recommended variety 53101 has maintained its position ; only at Benin has it been significantly outyielded by a number of improved hybrid selections.

Eastern Region.—The variety trials were laid down at Umudike, Abak, Abakaliki and Nekede (Owerri). The trials at Abakaliki and Nekede were not harvested because of late planting and poor growth.

At Umudike the local variety Ohupon yielded 5.6 tons per acre, which was a greater but non-significant yield over selected hybrids and recommended varieties. On the other hand at Abak a recommended variety gave a significantly higher yield, 5.0 tons per acre, than all other selections including the popular local variety Okpo Obubit, 2.5 tons per acre.

Acceptability

Tests were carried out to determine the local preferences for cassava tubers.

Benin.—One tuber from each of twelve varieties was ranked independently by four women. The pink exodermis of one variety was not visible. It was noted that differences were significant between treatments, using Kendalls coefficient of concordance, and good agreement was found between observers. On average, the variety Congo (44086) was most popular for its shape and skin characteristics.

Yandev.—Gari was prepared from 112 lbs of 11 months old tubers obtained from each of seven high yielding hybrids and the most popular local variety. The tasters, consisting of different people from Tiv division were asked to report on the flavour of the prepared gari and foofoo. Samples of the gari were stored in the laboratory for 80 days and scored for storage quality.

Out of the eight varieties tested, the local ranked sixth in flavour of gari and second in taste of foofoo. It should be noted that the local was a much lower yielder than the other varieties tested.

Umudike.—A further eight varieties were tested, but here the gari was scored on colour, flavour and texture. Two hybrids and a Nigerian variety were preferred to the local variety.

Abak.—At this station nine varieties were examined and scored on their flavour of gari and foofoo products. The local variety although it produced good gari gave a low gari percentage compared to the tested hybrids.

It was found that the acceptability of the cassava food products depended on the efficiency and skill in processing. From the gari tests carried out at three stations the results showed that the removal of the skin and cortex accounted for 30 per cent of the fresh weight ; 100 lbs of peeled cassava tubers gave a gari yield of from 28 to 36 lbs.

Prussic Acid Investigations.—In Northern Nigeria the preference is for a cassava which is sweet and has a low prussic acid content. It is also necessary to know whether the prussic acid content is affected by different ecological conditions, by the presence or absence of virus disease, and to confirm whether the prussic acid content affects the taste.

Thirty-four varieties collected from the Northern Region were grown at Umudike and Samaru. At harvesting the raw tubers were tested and classified into "bitter" or "sweet". Agreement was reached in twenty-nine of the varieties.

In an attempt to correlate prussic acid content with taste nineteen varieties were analysed by the chemist of the Ministry of Commerce in Enugu. An association was not found between prussic acid content and taste. The investigation is continuing of the classification of varieties into "bitter" and "sweet".

Agronomy

Plot experiments were carried out at Umudike to investigate three factors which affect yield.

(1) The farmer may use any part of the stem for propagating cassava and it is not known if differences exist in the rate and percentage germination of the different portions of the stem. Cuttings were taken from the base and top of the main stem and branches. After 21 days significant differences were found between treatments and it is proposed that the quickest establishment is obtained from planting basal portions and the slowest by planting apical parts. This work is being continued.

(2) In cassava experimental work, the failure of planting material to germinate is frequently found to be caused by termite attack. Five insecticidal dusts, Agrocide, BHC 0.5 per cent, Aldrin 2.5 per cent, Sevin 50 and Gammelane A were tested either by dusting along the ridge or by dipping one end of the cutting into the dust before planting. Good control was obtained by dipping the cutting. A further trial was laid down to determine whether the whole cutting or each or both ends should be dusted. Results show that it is more beneficial to dust the whole planting material. Aldrin 2.5 per cent dust was found to be the most effective insecticide.

(3) There are many different methods employed in planting cassava. The cassava stem or portion of it may be buried horizontally or at an angle ; also one, two or three cuttings may be planted per hole. A preliminary investigation was made using three growth types of cassava : high, low and medium branched ; and 1, 2 and 3 cuttings planted either buried, or at an angle.

There was a considerable variation due to varieties and it was found that there was no effect on yield due to the position of planting the cuttings. There was however, a significantly higher yield from three ($P=0.001$) and two cuttings ($P=0.05$) planted over a single cutting and a higher number of tubers was produced from three and two cuttings over one cutting but without any reduction in size of tuber. This investigation is to be continued.

PLANT PATHOLOGY

Plant Disease Survey

The Virologist has completed the draft of "Plant Virus Diseases in Nigeria" and it has been published as a Departmental Memorandum. It will be incorporated in the "List of Nigerian Plant Diseases" which is in course of preparation.

During the year the following diseases of economic plants have been recorded for the first time in Nigeria.

Cola.—Roots of moribund trees at Agege, Western Nigeria were internally infected with *Fusarium oxysporum* Schlecht. ex Fr., the widespread root-disease fungus.

Coco-yam.—Cladosporium colocasiae Sawada on *Colocasia*, causing leaf-blotching, and *Cylindrocarpon radicicola* Wollenweb., associated with a rooting corn of *Xanthosoma*, at Ibadan.

Cow-pea.—Three new virus diseases have been recorded which are seed transmissible, one was on a local variety at Ilorin, Northern Nigeria, the other two were on the varieties New Era and Paraguay 6 at Ibadan. One of the two latter diseases is readily sap-transmissible.

Beet Cercospora beticola Sacc. caused severe leaf-spotting of Swiss Chard (*Beta vulgaris*) at Ibadan.

Grape-vine.—Downy mildew, *Plasmopara viticola* (Berk. & Curt.) Berl. & de Toni, was widespread on vines grown in the Economic Collection at Ibadan.

Sisal.—Hendersonia toruloidea Nattrass caused large necrotic area on the leaves of sisal plants in the Economic Collection at Ibadan.

Euchlaena Mexicana.—A case of smut, *Ustilago maydis* (DC.) Corda, was recorded at Ibadan in the Economic Collection.

Panicum maximum.—Guinea-grass at Moor Plantation, Ibadan was infected with rust, *Uromyces leptodermus* Syd. and grey spot, *Pyricularia grisea* Cooke.

Coffee.—Colletotrichum dematium (Pers. ex Fr.) Grove, caused a leaf spot on *Coffee robusta* at Umuahia, Eastern Nigeria.

Rice.—The reported occurrence of 'bakanae' disease by the Rice Agronomist at Badeggi Northern Nigeria was confirmed. This is the first definite record of the fungus *Gibberella fujikuroi* (Saw.) Wr. on rice in Nigeria, although the symptoms have been noticed in previous years.

Rubber.—Armillaria mellea (Fr.) Quel. was reported infecting rubber on estates in Calabar, Eastern Nigeria and is becoming a serious problem despite control measures being applied.

Yams.—*Curvularia trifolii* (Kauffm.) Boedijn caused leafspots on *Dioscorea dumetorum* at Calabar, Eastern Nigeria. Leafspots on *D. cayenenis* at Abak, Eastern Nigeria were associated with a species of *Phoma.*

Pepper.—*Capsicum annum* plants at Umuahia, Eastern Nigeria were infected with *Cercospora unamunoi* E. Cast. (leafspot) and *Leveillula taurica* (Lev.) Arn. (powdery mildew).

When possible, notes on plant diseases reported by other workers in Nigeria have been filed in the central records maintained in the Plant Pathology Division and references added to the bibliography of Plant Pathology in Nigeria.

VIROLOGY

Virus—like Disease of Yam

The disease, previously reported as a suspected virus disease, was again recorded from the fertilizer trials on white and yellow yams at Ilora in the Western Region. The white yam tubers harvested from the 1961 trial, when about 5 per cent of the plants were infected, were used to plant the 1962-63 experiment and 2 per cent of the plants were infected.

Leaf samples from healthy and infected white and yellow yams were analysed for the major and trace elements. The concentrations of alumium, iron, manganese and titanium were higher in the diseased plants but there was no evidence of toxic quantities of these elements being present. The concentration of zinc, however, was only 17 p.p.m. in the diseased leaf samples of both white and yellow yams as compared with 39 p.p.m. in the healthy leaf samples. This aspect of the problem is being further investigated.

Cowpea Mottle Virus

Host Range.—The virus has been transmitted experimentally to *Glycine max*, *Phaseolus acutifolius*, *P. aureus*, *P. lunatus*, *P. vulgaris*, *Vinga cylindrica*, *V. sesquipedalis and Voandzeia subterranea.*

No infection was produced in twenty-seven other species of legumes or sixteen species in the families Aizoaceae, Amaranthaceae, Compositae, Convolvulaceae, Cucurbitaceae, Solanaceae and Tropaeolaceae.

Properties in Vitro.—When diluted with water, the end-point was between 1 in 50,000 and 1 in 100,000 in cowpea and 1 in 200,000 in French bean variety Masterpiece. The dilution endpoint could be increased to 1 in 250,000 when the dilutions were made with either 0.067M phosphate buffer (Sorenssen) at pH7 or Tris : HC 1 buffer (Gomori) at pH8. The virus was inactivated by heating for 10 minutes at 55°C but not 50°C and had a longevity invitro of between 24 and 27 hours at 21°C. The virus was precipitated by ammonium sulphate, nearly all the infectivity being recovered at 30 per cent and 50 per cent saturation. Solution containing 50-70 per cent ethanol precipitated more virus than 10-30 per cent solutions, but were not as effective as ammonium sulphate. Very little virus was precipated by acetone and solutions containing as little as 30 per cent acetone had a deleterious effect on its infectivity.

Field Trial.—The growth of Paraguay 6 and a local white-seeded variety, measured as the total dry matter content, when infected at either 2, 3, 4, or 5 weeks after planting was significantly less than the growth of healthy plants ($P=0.001$).

The poor yields that were obtained from the late season planting made it impossible to draw any conclusions from the experiment to investigate the effect of the disease on yield under field conditions.

Cowpea Yellow Mosaic Virus

The isolate of cowpea yellow mosaic virus that was made from locally grown cowpea at Igporin in Ilorin Province was shown to differ from the original isolate (S.R Chant, Ann. Appl. Biol., 47, 565-572, 1959) in its reaction on *Phaseolus mungo* and a local brown-speckled seed type of cowpea in addition to those hosts previously reported. In both these test plants, the symptoms caused by the Igporin isolate were not as severe. This isolate was also shown to protect against infection by the original isolate in cowpea variety New Era.

An antiserum was prepared to the Igporin isolate, and precipitation and gel-diffusion tests showed that there was a close serological relationship between the two isolates of the virus.

Field Trials.—carried out with New Era during the year have proved that when plants were infected with CYMV at least to 10 days before the flowers began to open, that is, about 4 weeks after planting, there was a significant reduction in yield. Infection at 5 or 6 weeks after planting did not reduce the yield significantly. The variety Paraguay 6, although not giving very good yields, appeared to be tolerant to the disease under field conditions.

A seed-borne Virus of Cowpea

One plant of local variety of cowpea, Shendam A, growing at Ilorin in the late season of 1961 showed conspicuous mosaic symptoms, and the virus subsequently isolated has been shown to be seed-borne in cowpea. In a limited number of tests, the transmission through the seed in New Era and a local white seeded variety of cowpea was 7 per cent and 19 per cent respectively. The leaf symptoms in these two varieties are a dark green and light green to yellow mottle accompanied by distortion and reduction of the leaf area. A 'blackeye' variety showed a light green diffuse mottle with no distortion, while a local brown-speckled seed type was immune. The virus has a limited host range in the Leguminosae which includes *Glycine max vars.* Hernon and Poona Black, *Phaseolus acutifolius*, *P. lathyroides*, *P. lunatus*, *P. vulgaris*, *Sphenostylis stenocarpa*, *Vicia faba*, *Vigna cylindrica* and *V. sesquipedalis*. *Celosia argentea* (Amaranthaceae) was the only species outside the Leguminosae that was susceptible to infection.

The virus was inactivated when diluted more than 1 in 100 with either distilled water or phosphate buffer and when heated for 10 minutes at 45°C but not at 40°C. The longevity in vitro at 20°C is less than 10 hours.

MYCOLOGY

Work on compilling the list of Nigerian Fungi continued and during the year, 143 specimens were added to the Herbarium, which contains a reference collection of Fungi of Nigeria. Apart from pathogenic fungi of economic plants, which are referred to above, 27 new additions to the Nigerian list were made. Special attention has been given to arable weed pathogens, and Gasteromycetes, both very neglected groups.

The Hirst spore trap was in operation for periods during the year, and particular attention was paid to the incidence of spores of *Pyricularia*, *Curvularia*, *Cercospora* and *Corynespora*. The results obtained from the relative frequency of the first two fungi are of interest in relation to the investigations currently being carried on on *Pyricularia* on cereals, especially rice and maize, and *Curvularia* on maize.

ENTOMOLOGY

Bemisia

This work was terminated in July and the results are being prepared for publication as a Departmental Memorandum. There remains no doubt that the control of the leaf-curl disease of tobacco transmitted by *Bemisia* is simply a matter of getting rid of old infected tobacco plants in and around about the area in which new plantings are to be made well in advance of the sowing date in the nurseries. This ensures that the white-fly will remain free from infection. Various pronouncements to the effect that the leaf-curl virus is carried by common weeds like *Vernonia* and various cultivated species were not confirmed by our investigations and observations.

There is no other reservoir of infection apart from tobacco. Hence the answer to the problem is a strictly enforced closed season for tobacco. In the absence of statutory powers it is well worthwhile buying up the few old plants in the vicinity of proposed new plantings and having them destroyed.

Cola Borer (Phosphorus Virescens Olivier)

Efforts were mainly directed at breeding out the Staphylinid predator found preying on *Phosphorus* larvae in their tunnels. The predators attain a length of over two inches and feed readily on *Phosphorus* larvae in captivity but none pupated. It is possible that they require a diet of pupae towards the end of their larval life or that there is another host altogether during the ultimate larval phase.

Similar difficulties were experienced in breeding out the abdominal parasites from the adult beetles. In many cases as many as 60 vigorous apparently full grown larvae were found in a single adult but none pupated.

Blood sucking Arthropods

A collection of blood sucking arthropods was made on cattle throughout the year. There was an interesting seasonal specific variation. During the early rains *T. pluto* was the dominant species. This was followed in June by *T. biguttatus*, *T. subangustus*, *T. secedens* and *T. taemiola*. The latter is by far the commonest species and it occurs practically throughout the year. *Haematopota decora* and to a lesser extent *H. pallidipennis* appear towards the end of the rains. The loa loa vector *Chrysops* is uncommon and so are *Thanmatocera akwa* and *Ancala fasciata*. Crepuscular and nocturnal tabanids which in some parts of West Africa occur in swarms in the byres at night and torment the cattle do not seem to occur in this region.

The tsetse-fly *Glossina palpalis* was collected throughout the year on the cattle, surprisingly enough even in the dry season.

Stomoxys calcitrans and *S. nigra* appeared in considerable numbers during the heavy rains.

Hippobosca maculata and *H. variegata* do not appear to breed in this region but are sometimes seen as fellow-travellers on cattle being droved down from further north.

Two species of ticks though of regular occurrence are never numerous. They are *Boophilus decoloratus* and *Amblyomma* sp.

Light Trapping

This was continued throughout the year. The destructive mole-cricket *Gryllotalpa africana* was regularly taken in large numbers, mostly teneral specimens with both sexes equally represented.

Yam-Beetles

Studies on the bionomics of yam-beetle species in Nigeria have continued and more information is now available on the distribution, migratory behaviour and biology of the different species. Two papers, one by Mr J. L. Gregory, and the other by Dr T. Ajibola Taylor, on aspects of the bionomics and control of yam-beetles have been prepared for publication as Departmental Memoranda ; and one paper on the taxonomy of yam beetles has been approved for publication. It is proposed to publish the entire work in an appropriate scientific journal when it is concluded.

Light-trap (Agenebode and Benin)

Light-trapping was carried out in two other yam-beetle affected areas, Agenebode in the Guinea Savannah Zone, and Okitipupa in the coastal vegetation zone along the creeks during 1962. The operation of the light-trap at Okitipupa was discontinued after the 'feeding migration' due to a low incidence of yam-beetles, but trapping continued at Agenebode throughout the year. The first yam-beetle was caught at the Agenebode light trap on June 4th and the last on 1st December. Light-trapping for yam-beetles was resumed at Benin during the 'breeding migration' (October-December) and the first yam-beetle was caught on the 14th October and the last on the 5th of January, 1963. At Agenebode a total of 31 and 15 yam-beetles was caught at the light-trap during the 'feeding' and 'breeding' migrations respectively. This is almost certainly due to the weak illuminance of the light source which was provided by an ordinary Tilley 'Storm' lamp. At Benin the number of yam-beetles caught during the breeding migration at a Robinson's type of light trap with Mercury vapour lamp was 74 ; this number is less than the number caught (98) on a single night (April 15th) at Benin during the feeding migration (April-June) and confirms the disparity observed earlier in the numbers of beetles caught at light-traps during the two periods of migration.

This is the first time that regular light-trapping for yam beetles has taken place in a yam-beetle affected area in the Guinea Savannah Zone. The 'feeding migration' in the zone commenced in June, 2 months later than in the Rain Forest Zone, and lasted about 3 months (June-August). Nevertheless the beginning of the feeding migration here appears also to be related to the onset of the rains, coming eight weeks after the first rains of the year. The period between the feeding migration (June-August) and the breeding migration (October-December) was almost too short to be distinct, being only 6 weeks or about half the duration in the Rain Forest Zone. There is the possibility that the two migrations might overlap if the durations of the migrations are prolonged.

Distribution

Studies on the ecology of yam beetles have continued and the pattern of distribution of the various species throughout Nigeria has been studied. *H. meles*, the commonest and most important species, economically, is distributed along the main rivers and some all-season rivers throughout the Rain Forest, Derived and Guinea Savannah Zones of Nigeria. The main factor affecting the distribution pattern appears to be the availability of suitable oviposition and breeding sites along these rivers. *H. appius*, the next species in importance appears to be restricted to the Rain Forest Zone, within an area with at least 40 inches annual rainfall. Annual precipitation is considered important to this species since breeding takes place in the yam heaps in cultivated areas away from the swampy river banks during the rainy season beginning in March.

Both *Prionoryctes canaliculus* and *P. rutopiceus* appear to be restricted to the Rain Forest Vegetation Zone. Until quite recently it was thought that they were restricted only to the southern part of this zone near the creek areas, but collection data have now shown that they occur also in the northern part of the Rain Forest Zone, but not outside it. More information on the biology of the species will help to elucidate the reasons for this restricted range of distribution.

Biology

Further studies on the biology of yam beetle species have been continued. Both *H. meles* and *H. appius* are now known to be univoltine. Techniques for the laboratory breeding of yam beetles from the egg to the adult stage have been improved. A hundred per cent eclosion of fertile eggs can now be obtained by incubation in sterilised or heat-treated soil in 3 x 1 inch open-ended glass specimen tubes standing in a petri-dish through which water is supplied at the rate of about 5 ccs. per tube every other day. Free water, though essential during the initial phase of embryonic development, was found to be detrimental during the latter part of the incubation of the egg; incubation in soil approximately at field capacity was therefore less successful. The average incubation period of eggs at room temperature in this medium was 18 days.

Larval mortality at the first instar was very high and the techniques for larval breeding are now being modified to overcome this. Further observations on first instar larvae in their natural habitat in the breeding areas will help in ascertaining their requirements. Although the first instar larvae feed mainly on humus and the second and third instars on grass roots in their natural breeding area, the second and third instars can feed and develop satisfactorily on yams in the laboratory. It has also been observed that in some yam-growing areas situated within the breeding areas, for example, Atani (Eastern Region), beetle larvae are often responsible for most of the damage to yam setts planted between November and March.

It has now been established that the life-history of *H. appius* is substantially different from that of *H. meles*. Unlike *H. meles*, oviposition and larval development take place in the yam heaps during the early rains and the damp habitat in the breeding areas are probably only used for hibernation. This means that although *H. appius* is second in importance to *H. meles* in terms of numbers and incidence, it is in fact potentially more injurious as a pest of yams because it passes through its life-history in the yam heaps and the yam setts, tubers and roots are liable to severe damage by larvae and adults.

Field and insectary observations in Ibadan have indicated that the damage to new yams may not actually take place until shortly before the insects embark on their breeding migration in November. This period of damage varies from about a week to a month. It seems therefore that the extensive damage to harvested yams could possibly be avoided by a slightly earlier harvesting. This will be investigated further.

Control

There were indications in previous experiments that the application of 2½ per cent Aldrin dust as a soil dressing at planting may be more effective than the recommended practice of the application of Aldrin dust to setts. One experiment for the comparison of three methods of application of insecticides : application to setts, application to setts and soil and application to soil alone, at the rate of one-eighth to one quarter of an ounce of Aldrin per stand on early and late planted yams, was carried out during the year at Bori—Ogoni. Two experiments to compare the effectiveness of 0.5 per cent 'Telodrin' dust (a new chlorinated hydrocarbon insecticide) with 2.5 per cent Aldrin, using three methods of application as above, in reducing yam beetle damage and increasing yields on November and February yams were planted at Egawo near Agenebode and Atani in Onitsha division where the yam beetle attack rate is reported to be about 60 per cent. The results of these three experiments will be available for analysis after the 1963 harvesting.

SUGAR CANE PESTS

A substation with laboratory and field staff was maintained during the year at the Bacita sugar cane estate to study the insect pests of sugar cane in an expanding sugar cane plantation. Initial efforts were concentrated on determining the identity of the different pest species, heir comparative abundance, and observations on their seasonal biology.

Stem borers

The first group of important pests belongs to the group of lepidopterous stem borers of the families Noctuidae and Pyralidae ; the commonest being *Sesamia botanephaga*, *Eldana saccharina* and an unidentified species of the *Chilo—Chilotrea* complex. Another stem borer species recorded, *Coniesta ignefusalis*, is of little importance on sugar cane but it is more common and of considerable importance on *Sorghum* species in Niger Province. Other hosts of *Eldana* and *Sesamia* include cereal crops like *Sorghum vulgare*, *Zea mays* and a number of wild grass species. In order of incidence and importance on sugar cane, the borers are : *Sesamia*, *Chilotrea*, *Eldana* and *Coniesta.*

Preliminary results have indicated that of the sugar cane varieties at present grown at Bacita, Co 419 appeared to be the most susceptible to stem borer attack and B 47258 the most resistant. Final conclusions cannot be drawn on the resistance of varieties until the attack rate can be compared when all varieties are at the right stage of growth.

Stem borer attack starts with the early rains and attains its full force in May. *Sesamia* is usually very much preponderant at this time but subsides to a lower level from June onwards with *Sesamia* and *Chilotrea* in approximately equal proportions.

The stem borers all lay their eggs on the leaves and bore into the stem of young plants causing "dead hearts". The count of "dead hearts" as an index of total borer damage is now no longer valid in view of the discovery of other causes of "dead hearts" in young tillers. Total borer damage will in the future be estimated from the count of dead hearts in which stem borer larva damage can be observed on dissection and those from which stem borer larvae can be recovered.

The parasite complex on stem borer species has no doubt been responsible for the low incidence of stem borers on sugar cane at Bacita. A total of 3 dipterous and 17 hymenopterous parasites and hyperparasites have been recorded. This mechanism of biological control is at present not completely understood and is to be investigated further. The possible outbreak of heavy stem borer attack during the period of the plantation's growth into a 6,000 acre farm is being kept in view, and insecticidal trials have been planned in readiness for this.

Beetles

Late in 1962 it was observed that up to 90 per cent of the dead hearts collected and dissected at Bacita were due to causes other than stem borer attack. On further investigation it was discovered that certain soil insects were responsible for the damage to young plants at or just below soil level, and that the damage, like stem borer attack, expresses itself in form of "dead hearts" when the attack reaches the central position in the tillers.

The larvae of the beetles were collected and bred out in the laboratory. The beetles which emerged have been identified as *Heteronychus licas* Klug, a dynastid beetle previously recorded as of minor importance on yams in Nigeria. This pest has been reported in Mozambique, Zululand, Ethiopia and some other sugar cane growing countries of the world, and is potentially a great economic pest in view of the fact that the Bacita type of irrigated farmlands or flooded plains appear to be ideal for high population build up.

Both larvae (second and third instar) and adults of *H. licas* are responsible for the damage to sugar cane tillers although the adults appear to be the more voracious feeders. Adults began to emerge early in February and there was a rapid build up of adult population from February-April, followed by a corresponding increase in the number of 'dead hearts' due to beetle attack.

Laboratory cultures of this species have been established at Ibadan and Bacita and a study of the biology is being carried out. A light-trap was operated at Bacita during March and April but very few beetles were caught. This indicated that there is probably little or no migration or redistribution of flying adults within the crop during this post-teneral period.

The general method of control is by early planting to get the cane to grow away before the period when the beetles are most prevalent. This method, if effective, would be a cheap method to adopt in combating the pest at Bacita. Otherwise dust and granular formulations of chlorinated hydrocarbon insecticides like Aldrine, Telodrin, Dieldrine etc., applied during the planting of setts, may provide an answer.

Field Pests of Cowpeas

Studies on the field pests of cowpeas and methods for their effective control were carried out in co-operation with the Legume Agronomist. The pest species were determined from the regular insect collections on the early and late crops of cowpeas at Moor Planttaion during 1962. Of over 60 species recorded on the crop, the following based on field observations of their incidence and degree of damage, appear to be of major economic importance.

Coleoptera

Ootheca mutabilis Sah.	Adults. (also a vector of the Cowpeas Yellow Mosaic Virus)	Foliage.
Barombia humeralis Lab.	Adults	Foliage and Shoots.

Coccinellidae			
Epilachna similis Thun. var. *assimilis* Muls	Adults		Foliage
Epilachna chrysomelina F. var. *reticulata* Wse.	Adult ..		
Lagriidae			
Lagria villosa F.	Adults		Foliage and Flowers
Chrysolagria sp. nr. *nairobara* Borch ..	Adults		Foliage
Chrusolagria cuprina Thoms	Adults		Foliage
Curculiomidae			
Apion sp.	Larvae		Flower buds
Cetonidae			
Diplognatha gagates Forest	Adults		Flowers
Meloidae			
Decaptoma sp. Oliv.	Adults		Flowers
Lepidoptera Pyralidae			
Maruca testulalis Gey	Larvae		Stem, Terminal shoots, Flowers and Pods
Tortricidae			
Laspeyresia sp.	Larvae		Pods
Hemiptera			
Coreidae			
Acanthomyia horrida Germ.	Adults		Pods
Anoplocnemis curvipes F.	Adults		Pods
Riptortus dentipes F.	Adults		Pods

Preliminary observations were carried out on the biology and nature of damage of these pests and the following were selected for a more detailed study : *Maruca testulalis* Gey. ; *Laspeyresia* sp. ; *Apion* sp.

A pilot experiment on the control of these field pests indicated that two foliar sprays of 20 per cent Dieldrin at the rate of 5.46 lbs. active ingredient per acre (0.1 pint of 20 per cent emulsion concentrate per gallon of water) gave a more effective control and higher yields than Gammalin, Aldrin, Malathion and control ($P=0.01$) and significantly increased yields by over 100 per cent of the control. Gammalin, Aldrin were next in that order, and Malathion was as poor as control. There was a clear indication from the degree of damage pods recorded even on the Dieldrin plots (41.5 per cent) that higher yields could be obtained by a more effective control of the pests during the pod stage. This will necessitate the extension of the spraying regime.

The subtreatments which attempted to compare spraying at 3rd and 5th weeks, 4th and 6th weeks, and 5th and 7th weeks after planting, indicated that the earlier sprayings were unnecessary for yield increases and that the probable effective spraying regime will have to commence about the 5th week and be continued at weekly or fortnightly intervals until a week

or two before havesting. Details of this experiment will be included in a Departmental Memorandum. A modified form of this experiment, with the introduction of 'Sevin' and 'Telodrin' to replace Aldrin and Malathion, and four spraying regimes to replace the present three, will be carried out on the early and late crop of cowpeas in 1963.

CHEMISTRY

This year saw the re-establishment of the Chemistry Division.

Spectrography Section

Mr J. C. Burridge arrived in October 1962 on a short term contract to set up the Spectrography unit. By the time he left in April 1963 the Hilger medium quartz spectrograph was ready for use. Work on the Large Spectrography has been suspended until a special type of electrode holder has been purchased. Most of the ancillary equipment (for example, microphotometers, comparators, lathe) has been set up, and orders have been placed for items that are not at present available here.

Chemistry Section

Since the chemistry laboratory was not ready, Dr M. N. Nwaji (who resumed duties in January) and other members of the laboratory staff of this Division worked in the Plant Physiology laboratory on the analysis of plant materials and soil samples. Meanwhile work has started on replanning and refurnishing what will become the chemistry laboratory.

SOIL FERTILITY

The Soil Fertility Unit is faced with the problem of establishing long-term and short-term maintenance of soil fertility experiments both at Moor Plantation, Ibadan, and in other areas with a view to searching for an alternative to bush fallow for the restoration of fertility to soils of forest and fringe high rainfall areas following several years of cropping.

One long-term experiment has been undertaken on Moor Plantation, Ibadan.

The primary object of this trial is to compare the effects on soil fertility of three fundamentally different farming systems, namely, continuous food cropping, food cropping alternating with a fallow, and food cropping alternating with a ley, and also to investigate the superimposed effects of various artificial fertilizer regimes.

The site chosen for the experiment had been used for arable crops for over fifty years and had previously reached a low level of fertility.

There are 8 blocks on four complete contour strips. Each block contains 6 whole plots split lengthwise for manure treatment by a grassed road for tractor movement, giving 96 subplots. The subplots are finally split into 4 sub-subplots each to accommodate the inorganic fertilizer treatments, resulting in 384 sub-subplots. In two particular blocks, rock outcrops have displaced three subplots which are then situated in the nearest unutilized contour strip. Each subplot is 100 feet long and 40 feet wide.

The phasing devices in this experiment enables us to make direct comparisons between treatments of the same crop at different stages of the crop-fallow cycle in the same year. It means that in the beginning of the experiment some of the cropped plots are designated a much later phase even though they have, in fact, only just been cropped ; with the view that this anomaly is of no practical disadvantage and will disappear in a few years. Each phase lasts two years and a full rotation therefore takes eight years. For continuous cropping, of course, the cropping sequence proceeds indefinitely.

The allocation of inorganic fertilizer treatments has not yet been made and is a matter of randomizing four levels of nitrogen for each subplot (that is, 96 times). The phosphorus and potassium treatments are combined with nitrogen levels and phases to give a complete replicate. The fertilizer treatments are omitted in the first cropping cycle in order to obtain information on site variability and it is hoped that when the cycle is completed, the analysis of results may give us some information on the respective merits of the five grass species which were planted on the site in 1957.

The plots were planted in August 1962 to cassava variety 53101 which is a short-term selection recommended for this trial. During November the fallow plots were all mown to a uniform height of six inches. Germination counts and uniformity tests taken during the first three months of planting have given no indication that there is any appreciable variability in fertility throughtout the site. During the next three months the plots were sprayed with BHC to arrest damage of cassava by grasshoppers, bunds were constructed on the south, east, and west borders of the experimental area to reduce the risks of gullying during heavy storms, and the bunds were planted with Axonopus compressus grass for stabilization.

The senior staff of the Unit toured Benin and the Eastern Region and discussed with the staff of the research stations at WAIFOR, Benin and Umudike.

PLANT QUARANTINE SERVICE

7th ANNUAL MEETING OF INTER AFRICAN PHYTOSANITARY COMMISSION

The meeting held in London from 15th to 19th October dealt with many aspects of Phytosanitary work of great interest to the Nigerian Plant Quarantine Service, particularly with regard to training, intermediate Plant Quarantine Stations and revisions in the Co-ordinated Legislation. The meeting was informed of the proposals for staff training in the Plant Quarantine Service and developments in this will be reported to the Commission. The question of the establishment of a new international Quarantine Station in Europe, raised by the Nigerian Delegation, was discussed and although no resolution regarding it was made by the Commission, the existing facilities are to be investigated more fully. The revision proposed by the Nigerian Delegation of the recently modified legislation regarding rubber budwood was not endorsed by the Commission. The necessity for growth in closed quarantine for treated budwood from *Dothidella* free areas is restricting the programme of introduction of promising clonal material from the Far East, and the matter will be taken up again with the Commission in due course. The Nigerian Delegation referred to the desirability of greater interchange of seed of tobacco varieties within Africa and endorsed the decision to request member countries to inform the Scientific Secretary of the Commission of stocks of tobacco varieties which were being held, and from which seed could be supplied.

STATIONS

Ibadan

The facilities at Ibadan continue to expand, during the year two new quarantine screen-houses for cocoa being constructed with funds provided by the Cocoa and Chocolate Alliance. The two houses, each 50 x 30 feet and 10 feet tall are divided into four compartments, the screening of 32 mesh vinyl gauze is double on all exterior walls, the two layers being separated by a 4-inch gap. Good growth has been observed in the houses and they will be of great value in expanding the programme of cocoa introduction into Nigeria. The small 12 x 8 feet experimental glasshouse has shown itself to be very satisfactory, the provision of continuous top ventilation and air inlets in the base having helped to keep the house quite close to ambient temperature. Overheating in strong sunlight is the biggest problem in the use of conventional glasshouses.

The Ibadan Station received provisional approval from the I.A.P.S.C. with a reservation regarding bacterial diseases in 1961, and to date it is not considered that complete isolation of plants in quarantine will be a practical possibility without the use of hermetically sealed plant growth chambers. Further technical information on the specification for a plant quarantine station will be necessary in order to progress towards the design of a completely safe quarantine compartment. At present the Ibadan facilities are adequate for coping with possible infection by nematodes and viruses, both very likely to be carried on vegetative material. Active growth of introduced fungal or bacterial diseases would be extremely dangerous and there would be no justification in accepting material into quarantine which, despite treatment, might be infected with them.

Lagos

The Plant Importation control work in Lagos was continued using the Apapa office as a base. Imported plant material is examined at the following places in Lagos ; Ikeja Airport, Passenger Arrivals Hall and Air Freight Shed ; Apapa, Altantic Commercial Baggage Hall, Parcel Post Depot ; Lagos, General Post Office. The work at Lagos is hampered by lack of Departmental living quarters and office accommodation at Ikeja for staff, but it is hoped that the situation will be soon remedied.

Kano

Inspection is carried on at Kano at the Airport and the General Post Office. The distance of the airport from the town and the siting of the Plant Quarantine Office half way between the Post Office and the Airport causes a good deal of inconvenience in arranging inspection duties. The proposed staff quarters at the air port and office accommodation there will help considerably to ameliorate the situation.

Kaduna

A small amount of mail entering Nigeria from Overseas goes to Kaduna in bond and is there inspected by Customs. As a number of consignments of imported plant material were entering by this route it was decided to post an inspector to the Parcels Exchange Office, Kaduna-South, and inspection was begun in December.

Calabar

Due to shortage of senior staff and the priority which had to be given to the large volume of work at Lagos and Kano it was necessary to close down the Calabar Station in August. There is virtually no plant importation control work to be done at Calabar and the station will probably be used eventually for a rubber clone nursery and rice research sub-station.

PLANT IMPORTATION

Permits

Four hundred and thirty-two Import Permits were issued during the year, over three times the number issued during the previous year. This increase is due to the growing public awareness of the need for Import Permits following the inspection work which was done on importation. Permits issued to private persons amounted to almost half of the total—for restricted vegetable seeds (mainly tomatoes and peppers) and vegetative material of ornamentals (mainly roses, bulbs and tubers).

Inspection

The number of separate consignment of plant materials inspected during the year at the five Plant Quarantine Stations were as follows : Ibadan 105 ; Lagos 802 ; Kano 630 ; Kaduna 27; Calabar 1 ; and Total 1,565. These comprised vegetable and flower seeds, plant products for consumption (seeds, grain and fruits), plants, bulbs and tubers of economic and ornamental plants and cut-flowers.

Detailed reports of the imports have been submitted monthly by the outstations and an almost complete record of the importation of plant material and products into Nigeria has been thereby obtained.

Plant Introduction

As in the previous year a list of all economic plant introductions made in 1962 was prepared for circulation to specialists in Nigeria in order to aid the interchange of plant material within the country and avoid the necessity for re-importation of plants.

Economic Plants

Seeds.—Introduction during the period included the following : benniseed from Gambia and U.S.A. ; castor bean from U.S.A. ; cocoa from Ghana and U.S.A. ; kola from Cameroun Republic ; cotton from Gambia and Sudan ; groundnuts from Gambia ; maize from Gambia, Mexico, Phillipines and U.S.A. ; pyrethrum from England ; rice from Cameroun, Gambia and Malagasy Republic ; safflower (*Carthamus*) from U.S.A. ; sorghum from Gambia and U.S.A. ; sunflower from Western Germany ; tea from Cameroun ; tobacco from Rhodesia ; tomato from England ; wheat from India and Sudan ; as well as numerous consignments of forest tree species from many countries.

Vegetative material.—The following were imported during the year : cocoa and cola cuttings from Cameroun Republic ; *Digitaria* sp. cuttings from Ivory Coast ; grape-vine cuttings from Spain ; sugar-cane cuttings from India, Kenya and U.S.A.

Quarantine

The following plant materials have been grown in quarantine and released to the importer : cocoa from Cameroun Republic ; *Digitaria unfolozii* from Ivory Coast ; cassava from Ghana and Malagasy Republic ; sugar-cane from Australia, India and Kenya. At the end of the year the following were still in quarantine : cocoa from Fernando Po, Ghana and Trinidad (via Kew) ; grape vine from Spain; sugar-cane from Kenya and U.S.A.

Rootstocks for the proposed importation of rubber budwood were raised in preparation for being budded in quarantine.

Plant Exportation

Two hundred and fifty-two consignments of plant materials for export were examined, the large increase over the previous year being mainly due to Certificates being required for plant products (dried onions, cowpeas, groundnut oil, etc.) exported to Ghana. Other items have included seeds and vegetative material of economic and ornamental and wild plants, forest tree seeds, pharmaceutical and botanical specimens and commercial shipments of benniseed, cotton-lint and groundnuts.

Legislation

The Draft Regulations which are in conformity with the co-ordinated legislation of the I.A.P.S.C. were submitted to the Ministry of Economic Development for approval in June. Some alterations have been made to the draft received from the Ministry of Justice for checking.

Training of Staff

On 31st March the two Plant Quarantine Officers proceeded to Washington, U.S.A. to take the U.S.D.A. three-month course in Plant Quarantine. The lack of specialised training in plant quarantine methods for the officers-in-charge of the Plant Quarantine Stations has been felt since the Service was first started, and it is hoped that this course of study will remedy this. Technical training at the post-diploma level in English is so far only available in U.S.A., which has a very highly developed Plant Quarantine Service.

The training of junior staff will be facilitated by the experience gained by the Plant Quarantine Officers in Washington and it is proposed that the three-month course for Plant Quarantine Inspectors will be developed on their return to Nigeria.

Publicity

No new publicity material was issued during the year, posters and passport slips have been in use and the illustrated folder has been revised ready for distribution when the Legislation is put into effect.

LIBRARY

During the year particular attention was given to recording the library holdings of serial publications, of which 389 titles are now listed as being currently received, one third of these being subscription periodicals, one third annual reports and other serial publications of the Nigerian Federal and Regional Government Departments and the remainder received free or by exchange from international organisations, Government Departments and research institutes outside Nigeria. Six new periodical subscriptions were taken out during the year.

Accessions of books totalled 197, and of microfilms and photocopies 56. Circulation of current periodicals issues was almost double that of the previous year, and total loan issues were 1,506. 52 publications were borrowed from external sources.

Twelve Memoranda published during the year were circulated within Nigeria, and to 97 overseas departments and institutes in 29 territotries. The Half-yearly Progress Report was succeeded by a Quarterly Research Bulletin of which 180 copies are distributed within Nigeria, chiefly to extension workers.

PUBLICATIONS

External Publications

SPENCER, R.—"A Rapid Method for Estimating the Leaf Area of Cassava (Manihot utilissima Pohl) using Linear Measurements." Trop. Agriculture, Trin., April, 1962 39 (2), 147.

MOUND, LAURENCE A.—"Studies on the Olfaction and Colour Sensitivity of Bemisia tabaci (Genn.) (Homoptera, Aleyrodidae)." Ent. exp. & Appl., 1962, *5*, 99.

TEWARI, G. R.—"Note on a Preliminary Investigation of the Efficiency of Two Introduced Strains of Cowpea Rhizobium in the Nodulation of a Local Cowpea Variety at Ibadan, Western Nigeria." Emp. J. exp. Agric., April 1962 *XXX*, (118), 155.

SLUYTERS, J. A. F. M.—"Some Information about Local Rice Mills and the Rice (Oryza sativa L.) produced in a Part of the Bida Division, Northern Nigeria." Neth. J. Agric. Sci., November, 1962, 10 (4), 297.

Departmental Publications

Memorandum No. 32.—"Performance of six white grained maize varieties in varietal hybrid combinations grown in Southern Nigeria." by C. L. M. van Eijnatten. June 1962.

Memorandum No. 33.—"An installation using ion-exchange resins for the large scale production of purified water suitable for plant nutrition studies" by R. Spencer. June 1962.

Memorandum No. 34.—"An analysis of girth and height measurements in Cola *Nitida*—progenies grown at Moor Plantation with the aim of selection of rootstocks" by C. L. M. van Eijnatten. March 1962.

Memorandum No. 35.—"Some considerations on maturity in maize and on the period from emergence of the maize seedling to anthesis (tasselling time), in Nigeria" by C. L. M. van Eijnatten. January 1962.

Memorandum No. 36.—"Yield reduction in maize due to a leaf blight caused by *Cochliobus Heterostrophus* at Ibadan" by C. L. M. van Eijnatten. July 1962.

Memorandum No. 37.—"Selection of Kola Trees from Kola Farms at Agege" by C. L. M. van Eijnatten. August 1962.

Memorandum No. 38.—"Resistance in some cowpea varieties to cowpea yellow mosaic virus." D. G. Robertson. August 1962.

Memorandum No. 39.—"An enquiry into the use of grain mills for processing maize and into preferences for various maize types with millers and their customers" by C. L. M. van Eijnatten and N. N. Okparanta. August 1962.

Memorandum No. 40.—"Report on co-operative maize yield trials carried out in Nigeria during 1960 and 1961" by P. M. Chinwuba. August 1962.

Memorandum No. 41.—"Selection of S-1-Inbred lines from Nigerian Floury varieties of maize" by C. L. M. van Eijnatten. October 1962.

Memorandum No. 42.—"Cassava in Nigeria. Part I. Eastern Nigeria" by M. J. Ekandem. December 1962.

Memorandum No. 43.—"Selection of Kola Trees (Cola Nitida) from locally planted Kola Farms at Agege II" by C. L. M. van Eijnatten. November 1962.

N.B.—Dates on Memoranda are those on which they were received and not the dates of final publication.

Quarterly Research Bulletin, No. 1, October-December, 1962.

Quarterly Research Bulletin, No. 2, January-March 1963.

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON RAINFALL

JANUARY-DECEMBER, 1962

Months	*Rainfall in Inches 10.00 a.m.*	*10 Years Average in Inches*	*No. of Wet Days*	*Cumulative Total in Inches*
January	—	0.25	—	—
February	0.57	1.15	1	0.57
March	4.81	4.25	10	5.38
April	5.42	5.16	11	10.80
May	6.43	6.32	14	17.23
June..	10.44	7.68	21	27.67
July	10.99	4.71	19	38.66
August	6.87	2.87	14	45.53
September	4.01	6.24	12	49.54
October	8.77	7.58	16	58.31
November	5.06	2.41	14	63.37
December	0.17	0.32	2	63.54
TOTAL	63.54	48.94	134	380.60

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON RAISED AND SUNKEN EVAPORATION TANKS

JANUARY-DECEMBER, 1962

Months	*Raised Tank Evaporation*			*Sunken Tank Evaporation*
	No. of Cups Added	*No. of Cups Withdrawn* 10.00 *a.m.*	*Evaporation in Inches* 10.00 *a.m.*	*Evaporation in Inches* 10.00 *a.m.*
January	240	—	4.80	4.80
February	256	9	5.51	5.51
March	172	157	5.19	5.19
April	152	179	4.88	4.88
May	95	229	3.75	3.75
June	50	402	3.40	3.40
July	55	372	4.67	4.71
August	85	258	3.25	3.25
September	93	145	3.03	3.03
October	110	224	6.49	6.49
November	101	141	4.26	4.26
December	182	—	3.81	3.81
TOTAL	1,591	2,116	53.04	53.08
MEAN	133	176	4.42	4.42

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON EVAPOTRANSPIROMETER

JANUARY-DECEMBER 1962

Months	*Mean Screen Maximum* °F (10	*Mean Screen Minimum* a.m) °F	*Mean Dry* °F (4	*Mean Wet* p.m.) °F	*Addition in cc* 8 a.m.	*Overflow in cc* 8 a.m.
January	94.5	68.5	93.3	73.6	46,500	12,370
February	97.1	70.1	96.2	74.5	42,000	8,000
March	94.0	71.9	90.3	77.7	46,500	44,740
April	90.4	71.2	88.7	78.9	45,000	55,140
May	89.3	70.6	86.7	78.6	46,500	40,470
June	84.9	67.3	81.5	75.7	45,000	66,700
July	83.2	70.4	80.1	75.3	46,500	87,470
August	81.5	69.3	80.0	74.7	46,500	65,380
September	83.2	69.9	81.2	75.7	45,000	61,530
October	88.2	70.3	85.1	77.6	45,000	57,790
November	88.5	71.1	86.6	79.0	45,000	61,340
December	90.5	70.2	89.5	77.7	46,500	21,130
Total	1,065.3	840.8	1,039.2	919.0	546,000	582,060
Mean	88.8	70.1	86.6	76.6	45,500	48,505

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON SUNSHINE

JANUARY-DECEMBER 1962

Months	*Duration of Monthly Sunshine in Hours* 6.00 *a.m. to* 6 *p.m.*	*Mean Duration of Sunshine in Hours*
January	252.6	8.15
February	210.2	7.51
March	197.0	6.35
April	170.7	5.69
May	206.9	6.67
June	121.4	4.05
July	96.3	3.11
August	76.0	2.45
September	78.4	2.61
October	177.2	5.72
November	190.4	6.80
December	228.5	7.37
Total	2,005.6	66.48
Mean	167.1	5.54

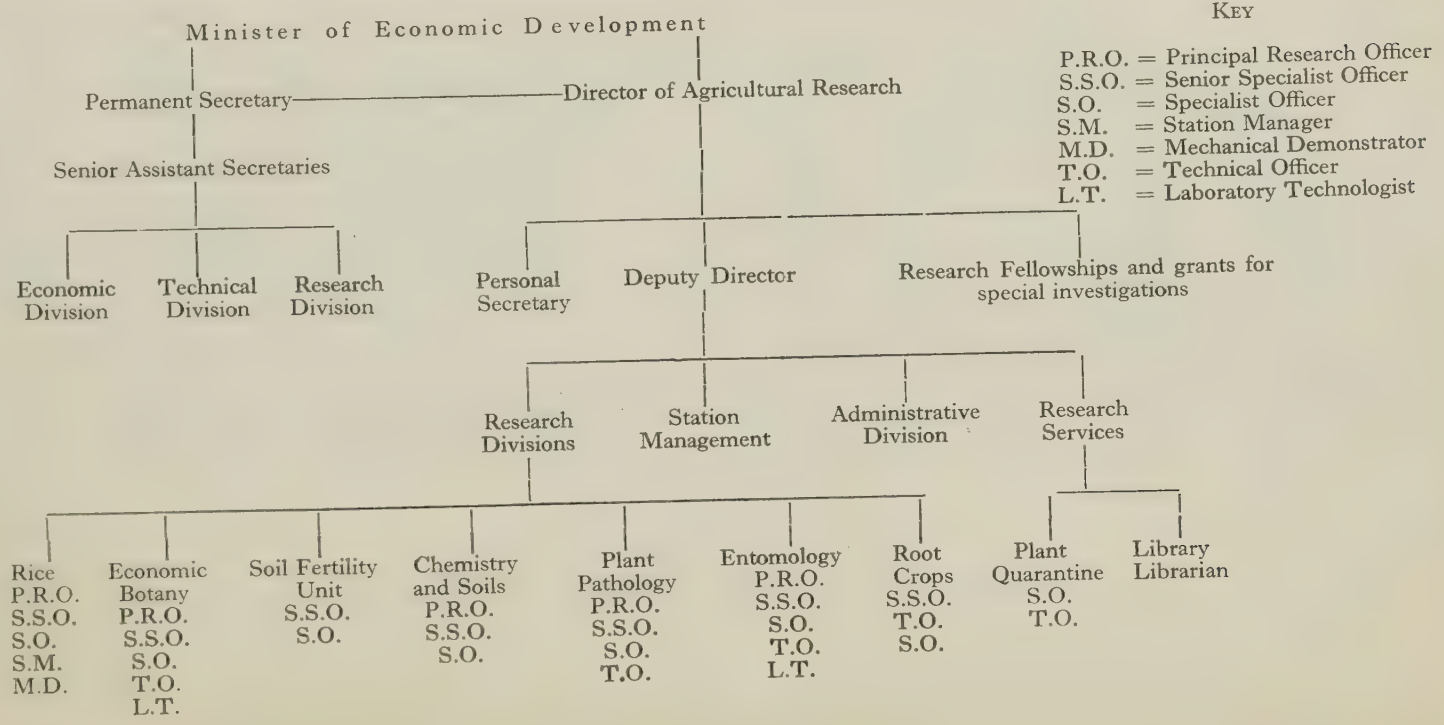
Meteorological Station—Moor Plantation (0703.25b)

REPORT ON TEMPERATURE DATA

January-December 1962

Months	Mean Maximum °F	Mean Minimum °F	Mean Dry °F	Mean Wet °F	Mean Relative Humidity %	Mean Grass Minimum °F	Mean Earth 1 Ft. °F	Mean Earth 4 Ft. °F	Mean Dew Point °F	Mean Vapour Pressure MBS	Mean Anemometer Wind Run Miles	Mean Water Maximum °F	Mean Water Minimum °F	Mean Dry °F	Mean Wet °F	Mean Relative Humidity %	Mean Earth 1 Ft. °F	Mean Anemo Metre Wind Runs Miles	Mean Dew Point °F	Mean Vapour Pressure MBS
					10.00	A.M.									4. P.	M.				
January ..	94.5	68.5	79.9	73.4	72.6	61.3	87.0	86.7	70.0	25.4	35.26	93.7	71.1	93.3	73.6	37.1	88.5	35.29	63.0	19.6
February ..	97.1	70.1	81.0	73.2	67.8	66.4	88.6	87.9	68.0	25.2	51.07	93.6	66.1	96.2	74.5	33.8	90.2	50.91	62.1	19.7
March ..	94.0	71.9	81.5	76.5	79.8	70.6	87.4	88.4	74.4	29.1	56.78	93.0	64.0	90.3	77.7	56.7	89.7	57.95	72.4	27.2
April	90.4	71.2	80.7	76.3	81.1	71.4	86.7	87.7	74.3	29.0	47.37	91.6	64.0	88.7	78.9	63.8	88.4	47.17	74.7	27.9
May	89.3	70.6	81.4	77.0	81.4	71.2	86.6	87.4	75.0	29.8	39.69	92.5	64.5	86.7	78.6	69.4	88.5	40.00	75.8	30.5
June	84.9	67.3	78.0	74.8	85.8	69.6	83.9	85.8	73.7	28.2	42.80	85.8	62.5	81.5	75.7	76.9	85.4	42.69	73.2	28.0
July	83.2	70.4	76.3	73.5	86.6	70.8	82.2	83.8	72.0	27.0	49.31	84.8	65.9	80.1	75.3	80.0	82.7	49.81	73.1	27.9
August ..	81.5	69.3	74.3	71.7	81.0	68.5	80.7	82.0	70.3	25.3	48.41	86.8	73.0	80.0	74.7	77.5	81.0	49.97	72.4	27.0
September ..	83.2	69.9	75.1	72.6	88.1	68.7	80.9	81.8	71.4	26.2	39.10	87.7	73.4	81.2	75.7	77.7	81.7	37.99	73.3	28.0
October ..	88.2	70.3	78.8	75.5	85.0	70.2	82.6	83.3	73.9	28.5	30.24	89.7	72.1	85.1	77.6	70.8	84.5	29.70	74.4	29.0
November ..	88.5	71.1	80.0	76.5	83.7	71.3	83.7	84.2	75.0	29.6	15.34	89.3	71.7	86.6	79.0	70.7	85.5	15.54	75.8	30.5
December ..	90.5	70.2	79.2	75.2	82.7	67.3	84.7	84.9	73.1	28.2	9.68	86.5	70.0	89.5	77.7	57.1	86.5	9.94	72.3	27.1
Totals ..	1,065.3	840.8	946.2	896.2	975.6	827.3	1,015.0	1,023.9	871.3	331.5	465.05	1,075.0	818.3	1,039.2	919.0	771.5	1,032.6	466.96	862.5	322.4
Mean ..	88.8	70.1	78.9	74.7	81.3	68.9	84.6	85.3	72.6	27.6	38.75	89.6	68.2	86.6	76.6	64.3	86.1	38.91	71.9	26.9

ORGANISATION OF FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT 31ST MARCH, 1963



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